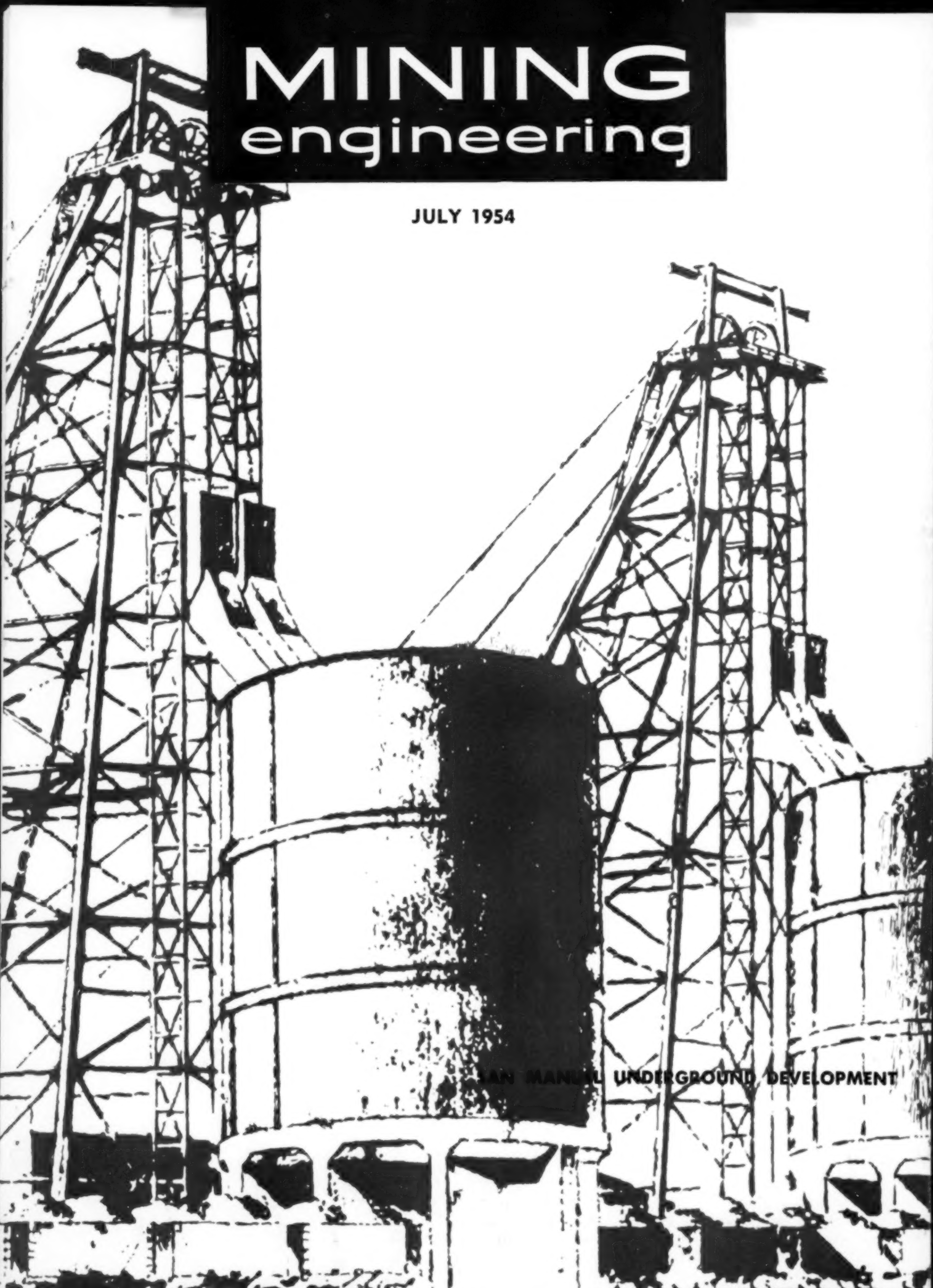
MINING engineering

JULY 1954



MINING engineering

VOL. 6 NO. 7 JULY 1954

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COVER

Headframes for the twin production shafts at San Manuel Copper will play their role in breaking underground production records. Shaft sinking and underground development, detailed in the articles starting on page 686, are now underway to gear this newest of the big coppers for a record 35,000 tpd production from underground. Not shown is the No. 4, or service shaft, which has the largest shaft cross-section in the State of Arizona.

FEATURES

ARTICLES

TRANSACTIONS

—Personnel Service—

THE following employment items are made available to AIME members on a non-profit basis by the Engineering Societies Personnel Service Inc., operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

MEN AVAILABLE

Mining Engineer, B.S. in mining engineering, graduate of University of Pittsburgh, School of Mines, January 1954. Age 30, single. Twelve years experience in steel mill. Will consider sales engineering work. Available immediately; prefers East but will consider relocating. M-87

Manager, 56, married. Mining engineer and metallurgist with 30 years experience all phases mining and milling operations, mine examinations, plant design, process development; 20 years managerial experience. Prefers western U. S. M-88-357-E-3-San Francisco.

Mining Engineer, 27, married, 9 months experience as shift boss, 4 months as trainee in large underground copper mine. Service requirements completed in Corps of Engineers. Experience in building and road construction. Available immediately; location immaterial. M-89.

Mining Engineer, 49, married, grown children. Operated since 1929, in Chile, Bolivia, Philippines, Venezuela, Honduras, as engineer, foreman, mine superintendent, manager, in underground and open pit mines; in copper, silver, tin, lead, zinc, antimony, nitrate, and gold properties. Fluent legal and business Spanish. Understands native labor and customs. Prefers small foreign property owned by large company. M-90.

Geologist-Mineralogist, A.B., M.S. in geology and mineralogy with experience in petrography and geophysics (seismograph interpretation) and ability to work with gravity, magnetic, and other geophysical techniques, including electric logs. Desires employment as a geologist, geophysicist or petrographer. M-91.

Mining Engineer, 35, married, B.S., M.E., 1942; 8 years varied experience in western mining industry; good record of profitable operations. Desires position with progressive company as mine manager or superintendent. Available 30 days; prefers U.S. M-92-5311-E-6-San Francisco.

POSITIONS OPEN

Junior Mine Engineer, 2-year contract with 2 months vacation. No U. S. income taxes withheld. Must be single. Salary, $3300 to $3600 a year plus bonus, room and board, and transportation. Location, Central America. F60.

Junior Engineer, mining or civil engineering graduate, for field work on gold dredging project. Must be single. Two-year contract. Salary, $3600 a year plus room and board. Location, Colombia. F44.

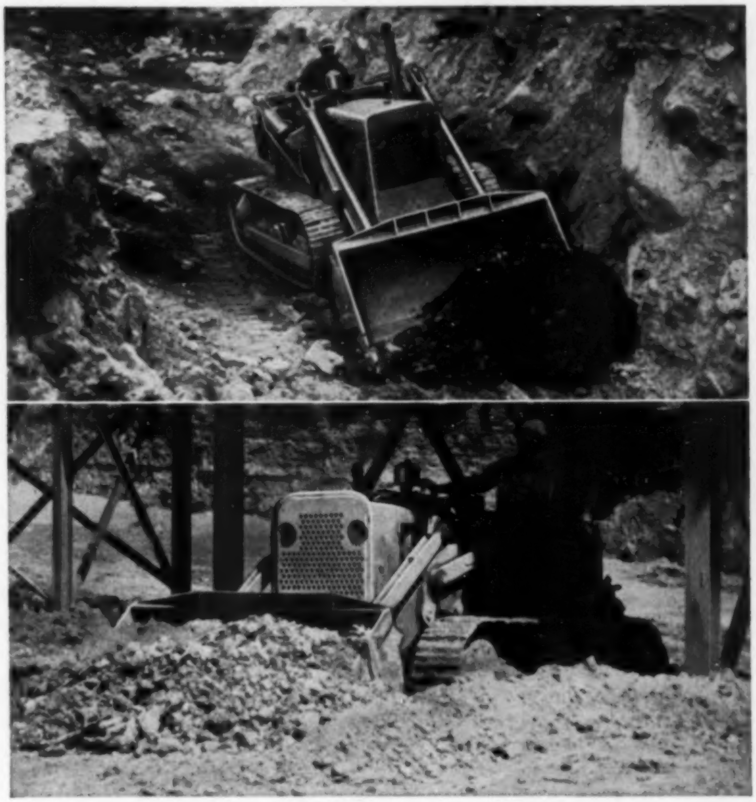
Diamond Bit Salesman for complete line of diamond drill bits and reaming shells. Should have active accounts; some knowledge of diamond drilling preferred. Commissions. State territory and experience. Location, New York, N. Y. Y9960.

Editor, nonmetallic minerals. Recent graduate or better. Must have flair for writing and knowledge of construction and raw materials. Will do technical writing on nonmetallic minerals, processing of raw material, and kindred fields. Salary up to $6000. Employer will negotiate fee. Some traveling. Car required. Location, Chicago. C1927.

MINING ENGINEER—Interested in management-operations, registered, age 36, married. Business training, ability to oversee examination, evaluation, layout, development, and operation of underground and surface mining. Thorough experience and knowledge of labor, all phases of mining, latest methods of mechanical mining. Conscious of production-cost, strong in statistical and capital cost. Willing to shoulder responsibility.

Box 100, AIME
29 West 39 St., New York 18, N. Y.

CHIEF GEOLOGIST: Wanted for Kilembe Mine, Uganda, a copper cobalt development. Applicants must be experienced in mining geology and have a flair for structural problems, particularly fold and fault structures. Salary depends on qualifications and experience—indicate your requirements. Apply to General Manager, Kilembe Mines Limited, P.O. Kilembe, Uganda.



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Allis-Chalmers offers a complete line of time-tested Tractor Shovels to mechanize mining operations in a new, better way . . . four sizes with standard bucket capacities from one to four cubic yards. These units bring year-round, time- and money-saving advantages on a wide variety of the toughest mine jobs . . . loading, stockpiling ore; handling sand, gravel and other bulk materials; cleaning up around hoppers, conveyors, shovels; building access roads; maintaining tailing dumps; digging, lifting, dozing and grading on many other mine jobs.

Important advantages include: more track on the ground for better stability, traction and flotation . . . truck wheels, support rollers and idlers that require lubrication only once every 1,000 hours . . . all-steel welded construction to withstand the shock and strain of tractor-shovel work . . . simplified hydraulic system for shovel control . . . lugability that assures unfaltering performance . . . minimum service requirements.

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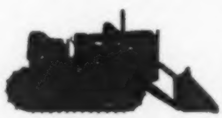
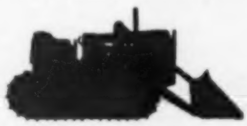


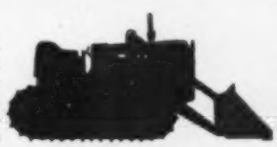
HD-5G

40 drawbar hp
Weight — 16,200 lb
Standard Bucket Capacity — 1 cu yd
Dumping Height — 9 ft, ½ in



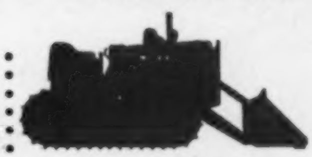
HD-9G

72 drawbar hp
Weight — 29,900 lb
Standard Bucket Capacity — 2 cu yd
Dumping Height — 11 ft, 4 in



HD-15G

109 drawbar hp
Weight — 47,580 lb
Standard Bucket Capacity — 3 cu yd
Dumping Height — 11 ft, 7 in
With Torque Converter Drive
135 net engine hp
Weight — 48,030 lb



HD-20G

175 net engine hp
Torque Converter Drive
Weight — 63,325 lb
Standard Bucket Capacity — 4 cu yd
Dumping Height — 12 ft, 10 in

ORDER YOUR BOOKS THROUGH AIME—Address Irene K. Sharp, Book Department. Ten per cent discount given whenever possible. Order Government publications direct from the agency concerned.

Who's Who in Engineering, 7th ed., *Lewis Historical Publishing Co. Inc.*, 265 W. 14th St., New York 11, N. Y., $17.50, 2935 pp. (20,000 entries), 1954.—This Bible paper edition accommodates 20 pct more material in considerably less bulk than the previous volume. The publishers have announced an extension of the reprint service: any individual listed may now order reprints of his record as it appears in the volume in quantities from 100 to 500 at a cost from $6.00 to $12.00.

Mining Year Book 1954, compiled by Walter E. Skinner, *Walter E. Skinner*, 20, Copthall Ave., London, E.C. 2, England, $7.00, 858 pp., May 1954. —Complete and up-to-date particulars on 970 world-wide companies, together with names and addresses of 1150 mining engineers, mine managers, and the companies in the book with which they are connected. Also included are directors and other officials, description of property and plant, operating data, capital, dividends, and financial results. A supplementary index contains names of companies that have appeared in previous volumes. *(Please order direct from publisher, book is shipped post free.)*

The Properties of Glass, by George W. Morey, American Chemical Society Monograph Series No. 124, *Reinhold Publishing Corp.*, $16.50, 591 pp., 2nd edition, 1954.—A famous monograph brought up to date. This edition is considerably larger and contains more tables and illustrations. Several of the chapters have been rearranged to include new material, and completely new sections on nonsilicate glasses and the effects of radiation on glass were added.

Metallurgy of the Rarer Metals, No. 1, Chromium; No. 2, Zirconium, by A. H. Sully and G. L. Miller, respectively, *Academic Press Inc.*, $5.50 and $7.50, 272 and 382 pp., 1954.—These books are the first and second of a series that will cover titanium, molybdenum, platinum, and others. The history and occurrence of the metals is discussed as well as production, physical properties, melting practices, and other pertinent data.

The Literature of Geology, by Brian Mason, *American Museum of Natural History*, $2.00, 155 pp., 1953.—A guide to the more important serial publications and significant literature on the geology of all countries. The first part is devoted to abstract journals, reference works, and selected texts in special fields; the second lists by country official geological survey publications, and other serial publications, the latest geological map, and the most useful recent book, bulletin, or article on the general geology of the country.

Engineering Contracts and Specifications, by Robert W. Abbett, *John Wiley & Sons Inc.*, $6.00, 429 pp., 1954.—This book on legal and business aspects of the engineering profession has been revised and expanded throughout. Material on contracts, specifications, and the presentation of legal rights and obligations in construction work has been considerably amplified, and other sections have been rewritten in the light of current professional practice.

(Continued on page 666)

"Fresh air really feels good!"

Underground workers' morale shoots sky high when you install Jeffrey AERODYNE Fans. These fans move out bad, stale air and bring in good, fresh air—efficiently and economically.

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When employees feel healthy and safe, production goes up,too. Ask one of the hundreds of mine operators who have turned to a leader in ventilation engineering—Jeffrey.

good mine ventilation promotes health, safety, increases production

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- Separate ball thrust bearing takes end thrust, relieving radial bearings from thrust load.
- Individual, positive blade adjustment secured by set screws in numbered socket holes.
- Air flow can be reversed for emergencies by reversing direction of rotation or (with engine drives) by reversing blade pitch.
- Oil level for internal self-circulating oil system is controlled by needle float valve regulating gravity flow from outside oil reservoir.
- 12A Series is designed for maximum pressure of 13" W.G. and volume of 20,000 to 700,000 C.F.M.

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PLANTS IN CANADA, ENGLAND, SOUTH AFRICA.

Books for Engineers

(Continued from page 664)

Principles of Geomorphology, by William D. Thornbury, *John Wiley & Sons,* $8.00, 618 pp., 1954.—A study of the origin, development, and characteristics of land forms. The author, who is associate professor of geology, Indiana University, and a research advisor for the Glacial section of the Indiana Geological Survey, emphasizes basic concepts and their applications to actual problems in the interpretation of complex landscapes.

Principles of Industrial Psychology, by Thomas Arthur Ryan and Patricia Cain Smith, *Ronald Press Co.,* $5.50, 534 pp., 1954.—An introductory survey of the entire field presenting a complete summary of the results of research and practical experiments. It covers selection, placement, motivation, fatigue, and other questions of importance to management, labor, industrial engineers, and personnel directors. The authors point out what the industrial psychologist can and cannot do at the present time and suggest directions for future research.

The Third Subsurface Geological Symposium, *University of Oklahoma,* $3.30, March 1954.—Ten papers presented Mar. 3 and 4, 1953 at the University of Oklahoma. The first five deal with subsurface geological logging techniques; the last five with a basic discussion on the occurrences of oil in the sedimentary basins.

American Chemical Industry: A History in Six Volumes, by William Haynes, *D. Van Nostrand Co. Inc.,* $15 ea. (6 vol.—$76.00).—This work tracing the development of chemical manufacturing in the U. S. is now complete. The first volume covers the background and beginning, 1608 to 1910. The next two volumes cover the World War I period, 1912 to 1922. The fourth volume covers the great mergers that resulted in tremendous expansion of competitive activities, mass production, prolific output and lower costs. The fifth volume covers the depression years, basic chemicals, and new chemicals. More than 200 company histories are included in the last volume.

Please Order the Books Listed Below from the Publishers

Free the Atom! 20 Questions and Answers by National Authorities on the Coming Industrial Development of Atomic Energy by Private Enterprise, *National Assn. of Manufacturers,* 14 W. 49th St., New York 20, N. Y., free, 30 pp., May 1954.—Taken from hearings before the Joint Committee on Atomic Energy, Congress of the U. S., 83rd Congress.

Economical Operation of the Small Steam Plant, *Bituminous Coal Research Inc.,* 2609 First National Bank Bldg., Pittsburgh 22, Pa., 50¢, 11 pp., illus., 1954.—A booklet developed to aid in maintaining economical, trouble-free operation of small coal-burning boiler plants. It covers plants up to 300 hp rating, or about 15,000 lb per hr maximum steam output.

The Constitution of Bone China, Part II, Reactions in Bone China Bodies, by P. D. S. St. Pierre, Technical Paper No. 7, *Dept. of Mines and Technical Surveys,* Mines Branch, Ottawa, Canada, 25¢ Can., 20 pp., 1954.

Minerals and Metals of Increasing Interest, Rare and Radioactive Minerals, by Richard T. Moore, *University of Arizona,* Tucson, Ariz., Arizona Bureau of Mines Mineral Technology Series No. 47, Bulletin No. 163, 30¢ (free to Arizona residents), 40 pp., October 1953.

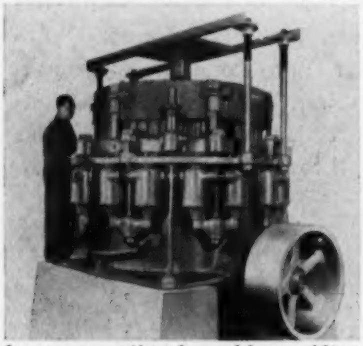
The Properties of Feldspars and Their Use in Whitewares, by Joseph C. Kyonka and Ralph L. Cook, Bulletin 422, *University of Illinois,* Urbana, Ill., 60¢, 34 pp., 13 figs., 1954.

Manufacturers News

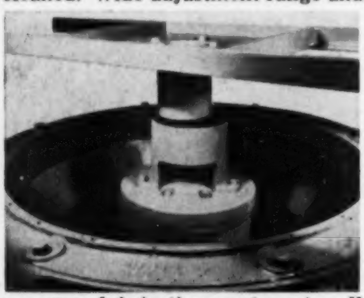
New Products • *FILL OUT THE POSTCARD FOR MORE INFORMATION* • Equipment

Gyradisc Crusher

Nordberg Mfg. Co. is now building the Gyradisc crusher to supplement the Symons cone crushers and provide finer reduction than available



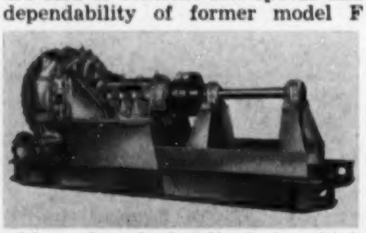
from conventional machines. Alternate release and impact action from compound gyration and rotation results in high percentage of fines. Protection is supplied by pneumatic release holding bowl to main frame, and the crusher can be restarted after power failure without being cleaned. Wide adjustment range and



pressure lubrication system to all moving parts are other parts of Gyradisc design which is now built in the 54-in. size only. Ideal feed is cone crusher discharge or equivalent product −1, −½, or −⅜ in., with or without fines. **Circle No. 1**

Dredge Pump

New GA and GAF dredge pumps introduced by *Morris Machine Works* are said to combine low speeds and dependability of former model F



with modern hydraulic design, high heads, and efficiency of former model G. Use of massive shaft, big bearings, and general construction are intended to provide reliability and durability. **Circle No. 2**

Carbide Tools

Addition of 12 new cemented carbide-tipped mining tools to its line enables Carboloy Dept. of *General Electric Co.* to offer a complete off-the-shelf selection of standard items. New tools include roof bolting and auger drill bits, heavy duty roof bolting drills, V-prong drills, and a ripper head bit. **Circle No. 3**

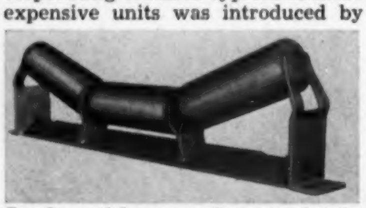
Underground Loader

Faster loading and increased safety for the operator highlight *Gardner-Denver's* new model GD10 underground loader with 4¾-cu ft dipper. Powered by two 5-cylinder radial

air motors, loader is reported to handle 1½ tons per min into cars. Daily maintenance for the GD10 has been reduced to two lubrication points requiring same kind of oil. Clean exterior design, low center of gravity, self-cleaning dipper with rounded bottom, and carefully placed controls are other outstanding features. **Circle No. 4**

Conveyor Carrier

Low cost belt conveyor carrier incorporating features typical of more expensive units was introduced by



Stephens-Adamson. Spun end 4-in. diam rollers have precision ball bearings and labyrinth seals permit lifetime lubrication. **Circle No. 5**

Pure Water

Adapting an age-old principle to modern technique, *Salem-Brosius Inc.* is introducing a new water purification method which kills bacteria and eliminates bad colors and taste. The Hyla process employing catalytic technique with complex metal salts has been studied at Johns Hopkins University and practical applications are being worked out by Salem-Brosius. **Circle No. 6**

Forged Steel Drop Ball

Long life and better wearing qualities for secondary breakage use are claimed by *Cape Ann Anchor & Forge Co.* for its forged steel drop

ball. Ruggedness and dependability are said to result from manufacture by forging from steel, stress relieving, and heat treatment. Octagonal shape of the Cape Ann forged steel drop ball, available in 2000 to 12,000 lb sizes, is designed to give maximum impact per blow. Connecting link is protected by deep recess. **Circle No. 7**

Flotation Mechanism

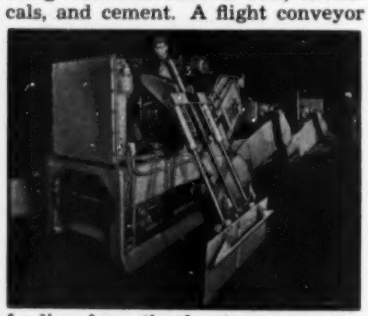
According to the *Denver Equipment Co.*, the new suspended unit shaft assembly for Sub-A flotation machines reduces down time for maintenance because unit can be lifted free from cell after removal of only four bolts and in less than 10 min. Parts are interchangeable with older models. **Circle No. 8**

Eating Made Easy

Feeding men away from base camps can be a headache, but *The Multiple Breaker Co.* with wide experience in packing special rations for civilian use and for the U. S. Armed Forces is now offering a line of packaged ration to ease this chore. Basic ration units are: one man-one meal and one man-one day. Custom-built rations are assembled to meet special needs. **Circle No. 9**

Unloading Fast

Cargo Handlers Inc. calls its box car unloader the latest word in handling materials such as salt, chemicals, and cement. A flight conveyor



feeding from the front passes material to articulating belt conveyors and out the car door. Hydraulically controlled side scraper arms reach out to help empty car. **Circle No. 10**

Free Literature

(21) MINING BATTERIES: *C & D Batteries Inc.* has a folder on Slyver-Clad batteries said to reduce hauling costs. Requiring no more space than conventional batteries, C & D batteries are claimed to have 20 pct more capacity and 35 pct longer work-life, due to a five-fold method of plate insulation and retention.

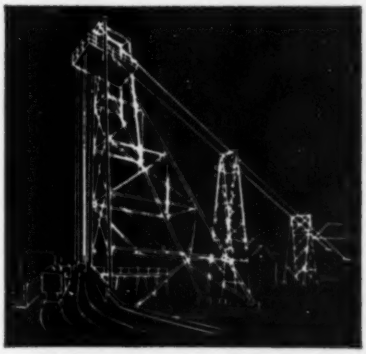
(22) FROTH FLOTATION: "Mineral Dressing Notes," bulletin No. 20, from *American Cyanamid Co.'s* Mineral Dressing Dept. describes the properties and applications of various Cyanamid chemicals used in ore beneficiation plants and processes. Flotation practice for various metallic ores, a summary of flotation methods used for various nonmetallic minerals, as well as chemical tables and a selected bibliography, are also included.

(23) COAL DRYING: *Link-Belt Co.* has published "New Development in the Heat Drying of Coal," a paper describing research in the use of Multi-Louvre dryers for drying and pelletizing fine coal. This paper was first presented at the Joint Fuels Conference in 1953.

(24) PUMPS, COMPRESSORS, ROCK DRILLS: *Gardner-Denver* has a compact but comprehensive catalog covering the complete line of G-D pumps, compressors, rock drills, and pneumatic equipment widely used throughout construction, mining, and general industry. Indexed dividers split the book into eleven product sections for greater convenience.

(25) MINE & INDUSTRIAL CARS: "Bethlehem Mine and Industrial Cars" from *Bethlehem Steel Co.* contains 59 pages of text and pictures describing the company's mine and industrial cars. Illustrated are cars of large and small capacities, with single and double-trucks. All-steel construction, forged steel wheels, automatic couplers, side-dump and end-dump, floating draw-bars are features pointed out.

(26) WIRE ROPE: *John A. Roebling's Sons Corp.* has an excellent booklet, "Wire Rope Recommendations and Catalog," that is divided



into 16 sections for each of the major uses of wire rope. Tab indexed for quick reference, each section gives detailed information and a system of code numbers provides simplified ordering.

(27) TANKS: Low assembly cost—no special workmen required, liquid tight joints, easily transported by mule back or airplane are some of the features brought out in bulletin No. T2-B5 on *Denver Equipment Co.'s* tanks made of wood, bolted and welded steel.

(28) TESTING: Newsletter No. 5 from *Gardner Laboratory Inc.*, manufacturers of physical testing instruments, is largely devoted to the portable Minitube mill for grinding pigments for test.

(29) CENTRIFUGAL PUMPS: *Ingersoll-Rand's* "Centrifugal Pump Fundamentals" defines various terms used in pump calculations and works out typical pump problems. The 12-page form 7287 is written in simple language and illustrated with easily understood diagrams.

(30) AIR COMPRESSORS: *Joy Mfg. Co.* has a new 36-page bulletin A-72 on Joy series 100, class WN-114 heavy-duty air compressors for industry. Illustrated are seven models of the compressor as a single unit for displacement capacities from 1186 to 1948 cfm as well as twin units that furnish up to 3896 cfm.

(31) MOISTURE CONTROL: *National Mine Service Co.* has introduced Dri-Pak to reduce moisture control and the corrosive effect of dampness in electrical compartments in and around mines. The flexible synthetic bag of dehydrating material reaches saturation in 4 to 5 months when it holds about 4 oz of water, which can be expelled. The contents can be reactivated any number of times by placing unit in oven at 325 to 350° for 3 hr.

(32) SKIDPROOF FLOORS: Neo-Floor, made by *Pennsylvania Salt Mfg. Co.*, consists of abrasive grit firmly anchored in a resilient neoprene coating. Applied as an air-curing liquid, using a brush or roller, it sets overnight and can be used on wood, concrete, steel or other common flooring.

(33) GROUND DETECTOR: *Parr Mfg. Corp.* makes the Brunt Faultfinder, used in electrical maintenance for the location of grounds in normally ungrounded electricals. A well-illustrated bulletin contains information on the purpose and operation of several models.

MAIL THIS CARD

for more information on items described in Manufacturers News and for bulletins and catalogs listed in the Free Literature section.

Mining Engineering 29 West 39th St. New York 18, N. Y.

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31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	Students are requested to write direct to the manufacturer.								

Name__________ Title__________

Company__________

Street__________

City and Zone__________ State__________

(34) PROBLEMS? Noxious trade waste nuisance problems? Turn them into profits. Conveying headaches? Perhaps the equipment is old-fashioned or ill-suited. The cur-

rent issue of "The Rex World," published by the *Chain Belt Co.*, also has stories on the R and RR Chabelco chain and features the "Drive Designers' Corner."

(35) LIGHTWEIGHT CEMENT: Information available from *Vermiculite Institute* covers "Poured-in-Place Vermiculite Concrete Roof Decks Over Paper-Backed Wire Lath" and "—Over Vented Steel Roof Decks." Data, specifications, and a report of load tests are given on this lightweight, fireproof, insulating concrete.

(36) STAINLESS STEEL: The second edition of "Allegheny Metal in Chemical Processing" from the *Allegheny-Ludlum Steel Corp.* is a completely revised 34-page book covering the use of stainless steel in handling acids and other chemicals. Also included are corrosion resistance data, fabricating information, and a stainless steel finder.

(37) TRACTOR-LOADER: The *Eimco* 105 with discharge heights to reach into high railroad cars will load at the rate of 250 to 400 yd of rock per hr, depending on travel distance. Bulletin L1032 shows such features as torque converter cushioned power, shifting from high to low—forward to reverse without clutch pedals, and alloy steel construction throughout.

(38) SAND, SLURRY, DREDGE: Completely new catalog No. 953 from *Allen-Sherman-Hoff Pump Co.* describes Maximix rubber protected Hydroseal pumps, developed to pump abrasive materials. Stressed are ability to outwear other designs, an efficiency close to that of clearwater pumps, and life-long ability to maintain capacity and head without change of speed. Full design and performance data are provided.

(39) SAFE CUTTING & WELDING: *Air Reduction Sales Co.'s* "Safety" is designed for welding and cutting operators handling oxyacetylene and arc welding equipment. The 32-page booklet details safety cautions and rules for using cylinders, torches, regulators, and hoses.

(40) CENTRALIZED LUBRICATION: "Studies in Centralized Lubrication, 1954" from the *Farval Corp.* explains the Dualine system. The Farval valve has only two moving parts—is simple, sure, and foolproof, without springs, ball-checks or pinhole ports to cause trouble.

(41) INDICATORS: Bulletin A-303 from the *Foxboro Co.* describes its portable potentiometers and resistance thermometers. Standard scales available cover −200° to +2800°F.

(42) LIQUID HANDLING: Where hard-to-handle chemicals or accurate metering are involved the *Lapp* Pulsafeeder is claimed to help solve pumping problems. Features include no stuffing box, all working parts submerged in oil, adjustable capacity while operating, and hydraulically balanced diaphragm.

(43) SCRAPERS & WAGONS: Mechanical and performance features of *Allis-Chalmers* models TS-200 and TS-300 motor scrapers, and of motor wagon models TR-200 and TW-300, are described in detail in two new catalogs, MS-452 and MS-453. In addition to specifications and other data, photographs show the versatility and efficiency of these models.

(44) APRON FEEDER: *Eagle Crusher Co.'s* new apron feeder has interlocking steel or manganese plates ½ in. thick, riveted to heavy roller chain. Intended to handle stone, rock, coal and other similar heavy materials, equipment is available with direct connected gear reduction drive or chain drive with clutch.

(45) REAR-DUMP TRAILER: *Athey Products Corp.'s* new PR21 rear-dump trailer is a high production teammate of the Caterpillar DW21 tractor. The new PR21-DW 21 team, hauling 31 tons or 22.5 heaped yd (based on 1:2 slope) of any material at up to 20 mph is first product of its type in the Caterpillar-Athey equipment line.

(46) RODS, TUBES, SHAPES: A 6-page bulletin from the Continuous-Cast Products Dept., *American Smelting & Refining Co.*, tells how

Asarcon 773 Continuous-Cast bearing bronze (SAE 660) saves money in maintenance, repair, and production by virtue of the advantages the product offers in length, size, machining time, metallurgical characteristics, and physical properties.

(47) ION EXCHANGE: Bulletin WC-111 from *Graver Water Conditioning Co.* is said to be the most comprehensive ever published by a company on demineralization of water. Included are flow charts, data on proper types of piping and fitting, estimated chemical operating costs of various systems; design, operation and mechanical factors.

(48) BULK-HANDLING: *Frank G. Hough Co.'s* Payloader is a tractor, shovel, loader, transport, boxcar unloader, bin and hopper feeder, and general utility unit. Brochure has photographs of major features.

(49) EARTHMOVING: *Euclid Div.*, General Motors Corp., has a new magazine with excellent photographs and a minimum of text. "Euc News" shows the work that Euclid earthmoving equipment does all over the world, speeding the movement of minerals to market and cutting industrial and highway costs.

(50) 7-TON CRANE: Built by *Harnischfeger*, model 55, the Miti-Mite, has all driving machinery contained in a single power box. It can be mounted on any truck of suitable capacity or it can be converted in the field for any type of service.

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THE FIRST IRON ore from Bethlehem Steel Corp.'s mine at Marmora, eastern Ontario, is expected this fall. Marmora is 29 miles north of Belleville, on Lake Ontario. Ore will be shipped across the lake to the company's Lackawanna plant in the Buffalo district.

CONTRACTS FOR 36,000 TONS of copper from Kennecott Sales Corp., and 64,000 tons from Anaconda Sales Co. were signed by General Services Administration. The purchases conclude negotiations for 100,000 tons of Chilean copper announced Mar. 25, 1954 by the State Dept.

UNITED ASBESTOS CORP., a Canadian firm, and American Smelting & Refining Co. have finalized long-pending arrangements that will result in the drainage of Black Lake, in Quebec. American Smelting & Refining, through its wholly owned subsidiary, Lake Asbestos of Quebec, is committed to the expenditure of an estimated $20 million for drainage of Black Lake, erection of a plant and milling facilities, and to bring the mine into production at a minimum of 4000 tpd. Work is to start immediately.

Companhia Vale do Rio Doce, Brazilian iron ore mining firm, produced 2,017,355 tons in 1953, compared with 1,794,870 tons the previous year. The company is aiming at an eventual output of 3 million tons annually. Assay of the ore produced last year shows 68.8 pct Fe and only 0.028 pct sulphur, according to the Brazilian Trade Bureau.

LARGEST OF THE PROJECTS undertaken this summer by the Geological Survey of Canada is Operation Baker, follow-up of the 1952 project, Operation Keewatin. The current edition will cover an area of about 60,000 sq miles. As in the first project, helicopters will play an important part. A fuel cache will also be established in preparation for a similar project in 1955.

There has been a steady trickle of metals through free ports from the Free World nations to the Iron Curtain, according to a report by the Dept. of Commerce. Soviet Russia received 13,386 metric tons of lead in 1953 through Antwerp.

INTERNATIONAL NICKEL CO. of Canada has been performing exploratory drilling for nickel and other minerals in the South Kawishiwi river valley, about 12 miles southeast of Ely, Minn. R. V. Whiteside of Duluth drilled on the Whiteside-Childers and associates lands along the contact between the gabbro and the granite. International Nickel acquired an option on the lands in 1952.

IT TOOK EIGHT RAILROAD CARS to deliver the 4 miles of conveyor belting to be used at White Pine copper mine in Michigan. Conveyor belts will haul copper ore out of the mine and then transport the material to the plant. Shipment was largest in 15 years made from the Hewitt-Robins Buffalo plant.

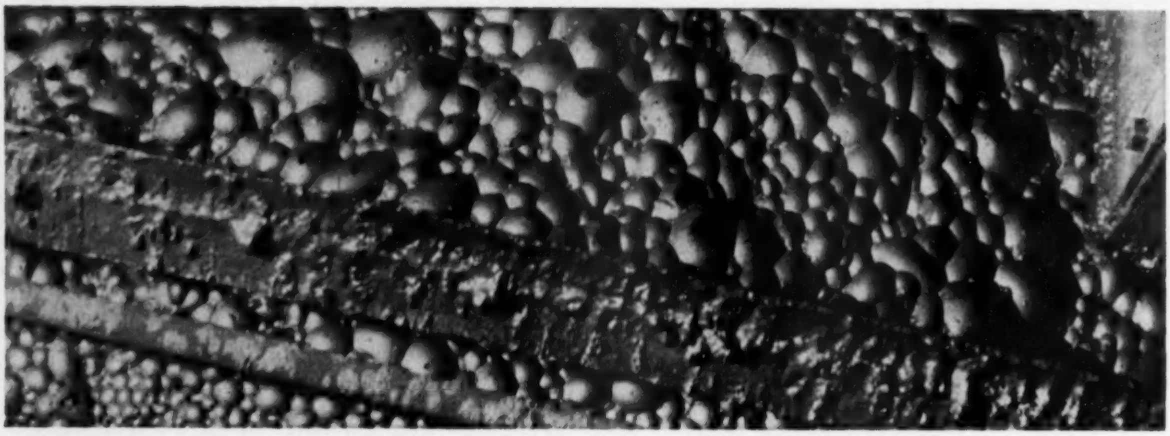
The Office of Defense Mobilization authorized the General Services Administration to start buying lead and zinc under the new long term stockpile program, but how much will be bought is a secret. Quantities will not be disclosed because of security. New purchase contracts will be issued after July 1 for additional lead and zinc contracts for the fiscal year. GSA expects to be authorized to buy other minerals and metals during the coming fiscal year, such as chrome, tungsten, manganese, and other newly mined domestic production.

SHERRITT GORDON MINES received $1.42 million from the U. S. as an advance on payment for recoverable nickel content of concentrates stockpiled at the Fort Saskatchewan refinery. Cost of Sherritt Gordon project to bring the Lynn Lake, Manitoba, property into production exceeded original estimates by 43 pct.

A. R. FISHER, president of Johns-Manville Corp., announced plans to develop underground asbestos mining facilities at the Munro mine, 10 miles east of Matheson, Ont. Sinking of an 800-ft main shaft, to be supplemented by a 300-ft service shaft, will start this summer. Meanwhile, open pit operations started in 1950 will continue. Part of the plan is construction of a permanent headframe which will also serve two other Johns-Manville orebodies in the area.

HUMBOLDT MINING CO., owned jointly by Ford Motor Co. and Cleveland-Cliffs Iron Co., is producing experimental iron ore concentrate from low grade deposits in Michigan's Upper Peninsula. Robert L. Bodor, mining properties manager of Ford's plant engineering office, said that Humboldt's iron ore concentrate is "far higher" in iron content than the Lake Superior "direct shipping" ores. Nonmagnetic jasper formation, composed of specular hematite, magnetite, and martite, with chert gangue, will be mined by open pit methods. Concentration process utilizing anionic flotation in air agitated cells was developed by CCI laboratory in Ishpeming, Mich. Ratio of concentration is about 2 to 1, and plant has estimated capacity of 200,000 tons of concentrate per year.

DOW



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Davison Triple Superphosphate Plant Nears Peak Production

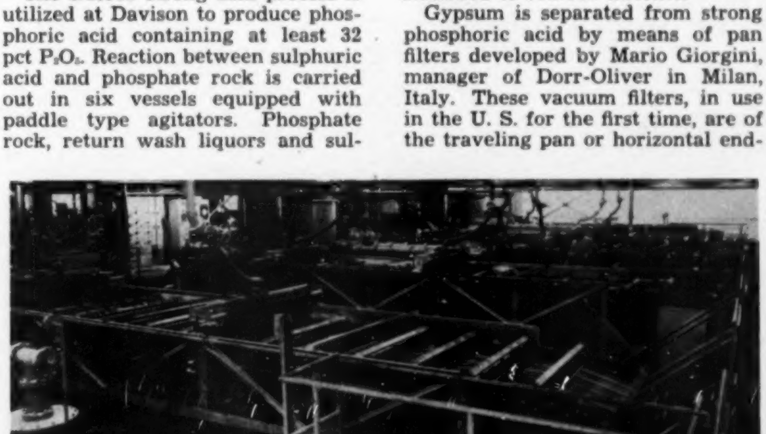
Triple superphosphate production section of Davison Chemical's new fertilizer plant is in left rear of central group of buildings. Gypsum disposal pond is in foreground.

Triple superphosphate production at the new plant of Davison Chemical Co. Div. of W. R. Grace & Co. at Bartow, Fla., is rapidly approaching rated capacity of 200,000 tons per year. Completely designed by The Dorr Co. as architect-engineers, this plant was initially put into operation last February. Three Dorr processes are employed in the plant for production of high strength phosphoric acid, evaporation of strong acid, and granulation of final product. In addition, in their first U. S. application Dorr-Oliver pan filters separate waste gypsum from strong phosphoric acid.

Design of the $10.4 million plant was initiated in early 1952 by the consulting engineering dept. and when construction, erection of equipment, and initial inspection were completed, the plant was started up under Dorr supervision. It was brought into large scale production aided by extensive instrumentation. Panel mounted electrical controls pinpoint operational difficulties in the various plant sections. The startup marked Davison's entry into the concentrated fertilizer field, and production will augment the output of triple superphosphate which last year amounted to approximately 1 million tons.

The Dorrco strong acid process is utilized at Davison to produce phosphoric acid containing at least 32 pct P_2O_5. Reaction between sulphuric acid and phosphate rock is carried out in six vessels equipped with paddle type agitators. Phosphate rock, return wash liquors and sulphuric acid are flash mixed into the recycled slurry in three small agitators. After three additional stages of air cooled agitation the completely reacted slurry flows to storage prior to filtration. A portion of the reacted slurry is continuously recycled back to the head of the system. Fumes and vapors are exhausted and scrubbed to remove fluorine.

Gypsum is separated from strong phosphoric acid by means of pan filters developed by Mario Giorgini, manager of Dorr-Oliver in Milan, Italy. These vacuum filters, in use in the U. S. for the first time, are of the traveling pan or horizontal endless belt type. They were developed specifically for handling strong phosphoric acid. This type of filter is capable of maintaining the filter medium at peak efficiency continuously without taking the filters out of service for cleaning. Strong product acid goes to evaporation and granulation. The waste gypsum filter cake is washed countercurrently in two stages starting with fresh water. Filtrate from this first wash is weak acid applied as the second wash. The second filtrate is returned to the head of the strong acid production system.



These five newly developed Dorr-Oliver Pan Filters for filtration of strong phosphoric acid and countercurrent washing of waste gypsum cake are integral parts of the new Davison plant at Bartow, Fla.

Strong product acid is concentrated up to 38 to 40 pct P_2O_5 in three single effect rubber lined evaporators equipped with outside heating elements. High velocity circulation and the Dorr evaporation system minimize scale formation.

Dry, closely sized, and cured triple superphosphate granules are produced on a continuous basis by the Dorr granulated fertilizer process. Additional raw rock is mixed in agitators with concentrated acid to produce a fluid slurry which in turn is mixed with recirculated fine product in blungers and fed directly to oil fired direct heat driers. Discharge from the driers is screened on double-deck vibrating screens which separate the product into three fractions. Oversize is ground and mixed with undersize for recirculation to the blungers. The closely sized intermediate fraction is the final product and is stored prior to bagging or bulk shipment.

Taconite Progress Recalls Edison Experiments at Ogden Mine

Thomas Alva Edison, the Wizard of Menlo Park, wagered $1.5 million on an idea that didn't pay off but that might have if he had lived long enough. Edison believed that low grade magnetic iron ores could be utilized, and during the late 1880's and 1890's put up three quarters of what eventually amounted to a $2 million investment in his magnetic separator and Ogden mine in northern New Jersey.

While Edison wasn't the only inventor to try magnetic separation, his activities at Llewellyn Park, N. J., and at Ogden were singular. Several innovations that were later to become standard mining practice were born at Ogden.

When Edison decided to launch the magnetic ore project, the existence of suitable deposits was not too well known. Because they were considered economically worthless, magnetic iron ore deposits were not recorded. Edison had designed a dipping needle. With needle in hand his men crossed and recrossed the country between the St. Lawrence and the Potomac. When a body of magnetic ore was discovered the ground was retraversed at intervals of 100 ft.

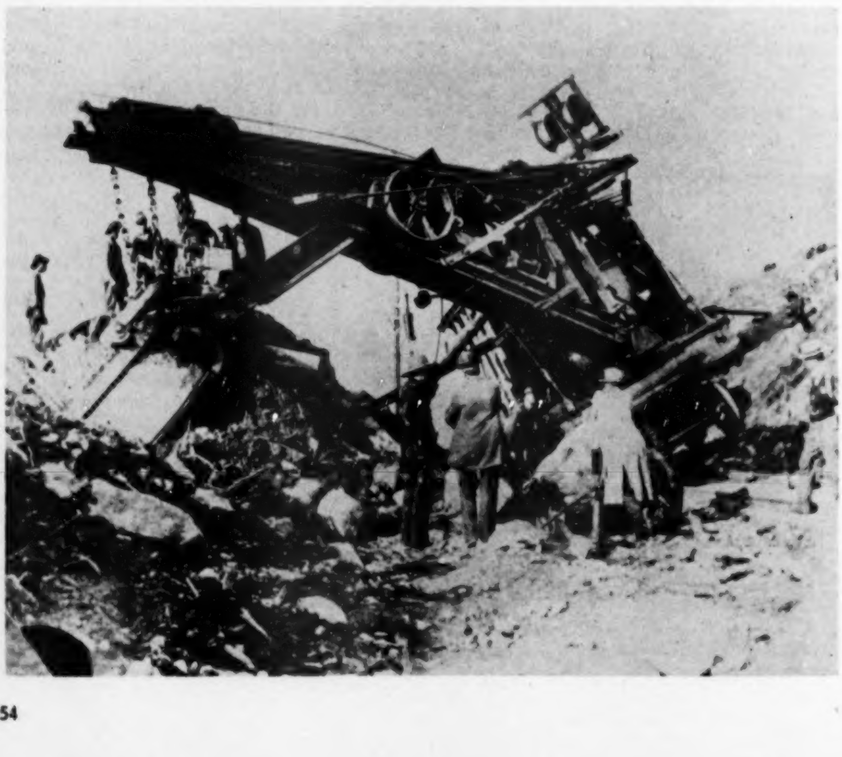
Edison and his associates acquired by purchase or lease some 16,000 acres. The Ogden property was one of the largest of the ore bearing areas. The extent of the orebody was developed by trenching every 100 ft across the strike of the deposit and taking samples at regular, short intervals. Tests indicated that ore averaged about 20 pct iron. Average width of the orebody was 600 ft and length approximately 11,500 ft.

Thomas Alva Edison also contributed the Edison cap lamp to the mining industry. He worked long and hard to develop a storage battery with an alkaline electrolyte. He had intended the battery for use in operation of light automobiles but it found wide use underground. More than 50,000 individual experiments were made before the battery was perfected.

The old Ogden mine workings were on narrow shoots or pockets of ore, from 3 to 12 ft wide and from 200 to 300 ft long. They went down to whatever depths pumps could be used economically.

Edison decided to quarry the whole mass of rock, using the most powerful steamshovel ever built. The shovel weighed 93 tons. Dynamite sold for about $260 per ton and Edison, fighting to keep costs down, made every effort to minimize its use. Explosives were used to break the rock into 5-ton masses which were later reduced by steam-driven crushers. A series of 2-in. drill holes 20 ft deep were sunk 8 ft apart. An Ingersoll compressor, placed in operation during 1897, served 15 drills. After blasting, the shovel loaded ore cars passing in a continuous stream.

Edison departed radically from traditional crushing methods. Instead of screening after every crushing operation, material passed through a series of machines without any attempt at sizing until actual separation began. Edison quarried, mined, and recrushed the ore to what was then considered fine size, then separated magnetic iron from nonmagnetic gangue, mixed the concentrate



Thomas Alva Edison leans over to inspect the shovel operating at the Ogden mine. Optimism about its capacity may have caused this tilt over. Man on the extreme right wearing the straw hat is Thomas Robins.

with a binder, pressed the product into briquettes, dried it in a furnace, and loaded into cars for less than 6¢ per unit of the iron content of the briquettes. E. Gybbon Spilsbury, commenting on the process, said:

". . . until the price of foundry pig shall advance to a figure at which it will be profitable to purchase 68 pct iron-ore at six cents a unit, it is not probable that the Edison works can be run continuously at a profit. It stands, nevertheless, a monument of perseverance in original research which certainly deserves our admiration."

The rock passed through a series of crushers until they came to the 14-mesh screen. The "giant" rolls were 6-ft diam, 6-ft face, and placed

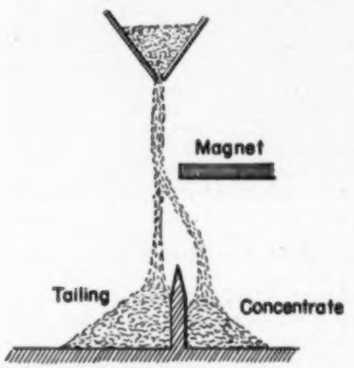


Diagram illustrates the simplicity of the Edison magnetic separator. Mesabi range discoveries halted Edison's experiments on utilization of low grade ores.

7 ft 3½ in. apart on centers. The rock went from the "giant" rolls to intermediate rolls. After a third set of rolls the rock went to a dryer. Crushing machines were driven by a horizontal compound engine, rated at 700 hp, using steam at 150 psi. Two Climax type boilers supplied the steam. After screening, the magnetic separator invented by Edison took over. The separator was simple in concept and cheap to operate.

"When a thin stream of material is allowed to fall by a stationary magnet, those particles which are subject to magnetic attraction are deflected from their path toward the magnet. Two parallel streams of material are formed, one behind the other, which may be readily collected in different receptacles."

Birth of the Ore Conveyor

One of the most important facets of Edison's Ogden mine operation was the necessity for keeping costs at a minimum. Conveyor belts had been used to transport grain, but before Edison employed them at Ogden, they had never been adapted for ore handling. The first belts used at Ogden were 20 to 30 in. wide, and as long as 500 ft between centers. Ore abrasion wore them out quickly. Repair and renewal bills were high. That was the situation when Thomas Robins, Jr., visited the mine for the first time. He noticed that the thin layer of rubber which covered the belt resisted the abrasion much longer than did a corresponding thickness of cotton duck which formed the body of the belt. Each layer or ply of duck wore more quickly than the preceding one. Wear was greatest in a line along the center of the belt.

Robins had a belt made with a thicker layer of rubber on the carrying side. It was also thicker in the center. Edison was quick to go along with the idea and experiments at the mine were successful. Eventually, using the mine as a kind of laboratory, Robins developed an improved mechanism for carrying the belt. It consisted of a set of rollers or idlers arranged on angle brackets, raising the sides of the belt to form a trough. It eliminated the need for guideboards and increased belt life.

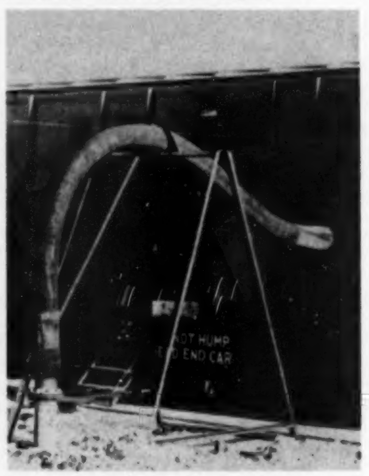
Edison pushed experiments in concentration and separation at Ogden as long as it appeared that work would lead to an economic process. One day the inevitable had to be faced. Mesabi range discoveries of tremendous reserves of high grade iron ore meant the end of low grade concentration.—M.A.M. & R.A.B.

Full Time Emergency Compressor on Wheels

A pair of heavy duty compressors, mounted on a railroad car, and capable of turning out 5000 cfm at 125 psi have been built by Clark Bros. of Olean, N. Y. The twin compressors have proven their ability to substitute for stationary units in an emergency, sustaining operation over a long period.

Complete with 500-hp electric motors, switchboard, transformers, and cooling and lubricating systems, the 138,000 lb of equipment fits into a single 60-ft railway boxcar. What's more, all components are standard, facilitating maintenance and repair; car and equipment vibrate no more than 0.030 in. in any direction; operation can be continued for long periods in any ambient temperature from −25°F to +125°F under severe humidity conditions. The unit will withstand dislocation or damage from shock equivalent to coupling the fully equipped car to a heavy stationary train at a speed of 10 mph, equipment is readily accessible for maintenance, and the car meets Assn. of American Railroad requirements for unrestricted boxcar travel in the U. S.

Two identical LCMA-4, two-stage air compressors, each with a 2500 cfm capacity, were modified to meet boxcar space. A factor that increases flexibility of the mobile compressor is its ability to use a power supply at either 4160 or 2400 v. The unit was built at the request of the U. S. Navy. The day the first mobile unit was completed, two stationary compressors at Charleston Naval Yard broke down. Sent to South Carolina, the emergency unit reached the yard at 2:15 pm and was in operation in slightly less than 24 hr. The mobile compressors worked regular 8-hr shifts for the next 42 days.



Less than 24 hr after reaching shipyard, the mobile compressor plant is ready for service, supplying 5000 cfm at 125 psi. Here, the compressor is in operation at Charleston.

Hanna Orders Huge Shovel From Marion

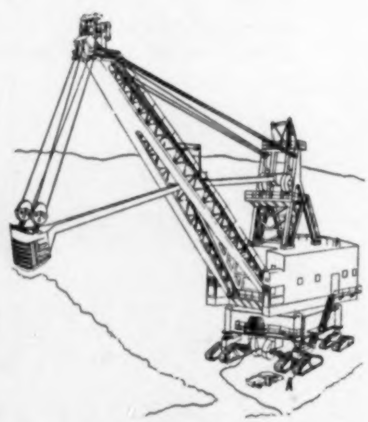
Twenty-five hundred tons of man-made monster will gobble up huge chunks of overburden for the Hanna Coal Co. Div. of Pittsburgh Consolidation Coal Co. sometime late in 1955.

The coal stripping shovel, the largest land vehicle ever contemplated by man, is being built by Marion Power Shovel Co. of Marion, Ohio. When finished the shovel will be 100 times as large as the common power shovel used in ordinary building projects. The figure is based on shovels weighing 50,000 lb for 1-yd dipper capacity. The huge bucket will be used to work deposits lying 90 ft below the surface. While bucket design is not yet frozen, its capacity may well be 60 cu yd, making it possible to move close to 100 tons of earth every 50 sec.

When finished the unit will be 50 pct larger than any existing equipment of its kind. Total weight will include 1 million lb of ballast. From ground to peak of the boom, the shovel will stand 145 ft, as high as a 12-story building. Each of eight crawler treads, mounted in pairs, measures 8 ft high, 22 ft long, and is 54 in. wide.

One of its most spectacular features is an office type elevator to be used to ride up to the control section. It will carry 1000 lb or 3 passengers. The elevator shaft will be placed in the hollow, 6-ft diam center pin.

Power for the giant will come from 16 motors turning out 4500 hp. It will cost about \$2½ million to build the shovel.



Relative size of the 100-ton capacity coal stripping shovel being produced for Hanna Coal Co. Div., of Pittsburgh Consolidation Coal Co., can be seen by comparing man and car with machine in the line drawing. An elevator will take personnel to control point of the shovel. Operation of the Marion-built shovel is expected by late 1955 in southeastern Ohio coal stripping.

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Why FluoSolids? Well, mostly because it involves techniques that are radically different from conventional drying methods. More specifically, because it lets you control temperature precisely and automatically (within 10 to 20 degrees). You'll get completely uniform temperature throughout the entire fluidized bed without hot spots — and that means product uniformity. Oil, Gas or Coal can be used as fuel.

There are other advantages too. You can cut fuel requirements by the use of a multiple compartment FS Reactor — which puts otherwise wasted heat to work. You'll find operating costs low because of complete yet simple instrumentation. And maintenance costs are surprisingly low because no moving parts are required in the Reactor itself.

Important point is though, FluoSolids is the best answer yet to the critical temperature drying job. And from the capacity standpoint, single units can handle from 10 to 500 tons per day depending upon individual job requirements.

We'd like to send you more detailed information. No obligation of course. The Dorr Co., Stamford, Conn.

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A new flotation process has been developed by Potash Co. of America, using an amine flotation reagent. Beyond that, the new approach is reported to depart completely from earlier techniques used by the company and does not use starch or any starch-like substance.

With this new process, PCA is doing something similar to the work of L. D. Anderson, whose patent started flotation of potash from ore. But, as described in the patents of A. J. Weinig, Sr., it eventually proved more economical to float the salt and clay from the ore, leaving the potash behind.

Potash Co.'s sylvite ores have been showing an increasing amount of foreign matter, including other potassium compounds. The situation called for a new handling method for the growing complexity of the ores. The amine process has a high tolerance for impurities in the brine.

In 6 months of pilot plant operation, spent checking laboratory findings, PCA reports complex ore results were consistent and "no serious difficulties have been encountered." Changes are being made in the refinery for a trial run on one of the flotation units. After tests of equipment changes are completed the full scale unit employing the new process will be started up.

Response from the Patent Office has been encouraging, indicating that PCA's development represents a novel solution. Original work on the process was done by E. A. Schoeld, Melvin Fritschy, and Roger Nelson. Joseph Reiter designed the pilot plant and supervised operation of equipment. Two people per shift operate the pilot plant on a three-shift basis. Work has been observed by refinery supervisors who take turns assisting the day shift.

Potash Co. feels that the new process will differ greatly from current operations and it may take time to attain a well-balanced procedure at the refinery level. No fundamental obstacle is anticipated.

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THE Senate Finance Committee has approved a plan put forward by Senator George W. Malone (R-Nev.) granting a 23 pct depletion allowance covering 27 separate strategic and critical minerals. Senator Malone has been pushing the amendment to the Internal Revenue Code during executive sessions held by the Senate Finance Committee, headed by Eugene Millikin (R-Colo.). The committee has been holding both executive and open sessions on the revised code. If the amendment passes through the House and Senate and is then signed by the President, it will mean tax deductions up to 23 pct can be taken by companies for depletion of reserves of the following minerals: antimony, asbestos, bauxite, beryllium, bismuth, cadmium, celestite, cobalt, columbium and tantalum, corundum, fluorspar, graphite, kyanite, manganese ore, mercury, mica, nickel, platinum and platinum-group metals, quartz crystal, tin, tungsten, vanadium, thorium, block steatite talc, ilmenite and rutile, zircon, and chromite.

"Such a break in heavy tax payments certainly will help establish a proper economic mining climate," the Senator said. "This action will encourage the development and production of our strategic and critical metals and minerals."

The Malone amendment refers to HR8300, passed by the House as the revised Internal Revenue Code. Under the new code percentage depletion allowances amounted to only 15 pct with the exception of asbestos which was fixed at 10 pct.

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PRESIDENT Eisenhower's compromise on Reciprocal Trade Agreement extension has cast a shadow over Canadian mineral producers. They fear a 200 pct increase on import duties of refined zinc and 140 pct increase on lead will hike tariffs from 0.7¢ per lb to 2.1¢ and 1.0625¢ to 2.55¢ per lb, respectively. Reports that the Tariff Commission supports industry-requested increases on metal content of zinc and lead concentrates also has them worried. Better than one third of Canada's lead and zinc production goes to the U. S.

On another Canadian front, Sherritt Gordon Mines reports that its Lynn Lake property is up to expectations in initial nickel-copper production efforts. Production is more than original estimates anticipated and the mill has been able to handle 2300 tpd, or 15 pct above rated capacity.

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THIS is the era of the neurotic atom—with the little monster throwing king-sized tantrums all over the lot. Everyone talks about the peaceful uses of the atom—but thus far uses have been confined to a small area. The big noise it makes is still the headline catcher. On the other hand, the atom bomb's older brother, dynamite, is still in there playing a big part in American industry. Quietly—or as quietly as such stuff can be—dynamite usage has shown steady increases to the point where some 757 million lb were set off last year by various industries. A mere 425 million lb were used annually during World War II.

Strangely enough, the moribund coal industry is the principal customer for the nation's output of dynamite, using some 29 pct of the total production in 1953. Next in line were the quarry operators who bought some 23 pct. Metal mining consumed approximately 167 million lb; construction, 115 million lb; and seismographic oil prospecting, 63 million lb.

Strip mining may be the reason for coal's role as biggest customer. Dynamite helps remove the tons of overburden rapidly and cleanly. With dynamite production in 1970 expected to reach 1.2 billion lb, it is predicted that one third of the output will still go to the coal industry.

Dynamite has gone through several changes since its invention in 1866 by Alfred Nobel. Repauno Chemical Co. began production in the U. S. in 1880, with the du Ponts eventually gaining two thirds ownership of the company. By 1912 Du Pont had built dynamite into a tremendous business—and then Government stepped in to split the company. Hercules Powder and Atlas Powder were offshoots of the trust busting, but Du Pont is still the top pro-

ducer. Remainder of important production is by American Cyanamid Co. and Olin Industries Inc.

Blasting techniques have improved tremendously in recent years. One of the things credited with making for better control is the millisecond delay. Last year, Atlas coupled alternate-velocity loading to millisecond delay. Rock breakage is started with low velocity blasts—followed by a high velocity finisher.

Probably one of the most unusual changes in dynamite is its packaging. Instead of wooden boxes, dynamite is now shipped in fibreboard packages. They cut down on freight charges and are more dependable under adverse shipping conditions. Larger sizes of dynamite, from 5 to 12 in. diam, are shipped in their own fibreboard skin. They can be removed from the delivery vehicle and put right to work. The new packaging has helped keep dynamite prices down. More than likely the price would have shot up much more than the 60 pct increase from World War II levels without these developments in shipping.

EDWARD F. Mansure, General Services Administrator, announced that the U. S. Government-owned nickel plant at Nicaro, Cuba, returned $1.1 million to the U. S. Treasury originally loaned to Freeport Sulphur Co. and its subsidiary Nicaro Nickel Co. The money was advanced to permit Nicaro Nickel to gain title to the ore deposits which still feed the plant. At the same time the task of building and operating the huge nickel plant was given to Nicaro Nickel. The original sum was one of the first in a series of investments which have amounted to $50 million. Bulk of the investments is represented by the plant itself.

Nicaro Nickel completed the redemption of 11,000 shares of preferred stock, at $100 per share, which the Government received 12 years ago as token of its stake in the mines, with a final payment of $600,000 in principal and $9600 in dividends figured to May 24, 1954. A total of $1,408,600 was paid by the subsidiary. The excess $308,600 represents dividends cumulated at 4 pct per year since October 1946 on preferred certificates outstanding.

The first payment, $775,000, was made Dec. 31, 1952, less than 12 months after the plant had been restored to operation. Six years accrued dividends, $275,000, were included in the payment. Dec. 31, 1953, the company paid $24,000 as one years dividends on the balance. A few months later, by formal notice of intention to redeem the remaining 6000 shares, Nicaro Nickel moved to close the transaction of May 24. Payment was offered and accepted prior to the paid-in-full date.

Treasury reimbursement flowed from royalties which the U. S. paid to Nicaro Nickel for the ore. The company received more than $3.4 million since operations were renewed in January 1952.

Nicaro is currently operated by Nickel Processing Co., whose majority stock is owned by National Lead Co. Production is at an annual rate of 28 million lb of nickel per year. The plant has completed 28 months of uninterrupted operation. A 75 pct capacity expansion has been authorized by the Office of Defense Mobilization and is now being moved from planning boards to the construction stage.

Along with his announcement of the repayment of the original loan, Mr. Mansure commented: "Essentially a nonsubsidized Government operation at present, Nicaro is an asset of growing value to the United States and Cuba. Although this reimbursement is only a small fraction of the Government's total investment in Nicaro, it is a tangible demonstration of the plant's great potential as a going industrial enterprise for Cuba as well as a source of nickel for the United States.

"We will bring the potential nearer reality as we press steadily forward with our plans to enlarge the plant and convert it, by lease or sale, into a permanent commercial venture as soon as it is on a solid financial footing. . . ."

BOOMING Bathurst isn't booming—or at least not in the rousing style of a year ago, when Brunswick Mining & Smelting Corp. set off a real old-fashioned staking rush with its discovery of a 100 million ton orebody.

According to *The Northern Miner*, the kind of work that is being carried out now is the type that will probably go along for years. An area that contains the kind of deposit Bathurst does is not likely to lose its attraction as a major hunting ground. Work going forward now at Brunswick Mining is somewhat on the prosaic side—road building, power line construction, and shaft sinking operations. Keymet Mines, expected to be the area's first producer, suffered a serious setback when its mill burned down. A new mill should be completed by fall.

Diamond drills are in evidence but not in boomtime strength. An outfit which had 11 rigs going at one time is now operating three. One reason advanced for the sudden decline in Bathurst exploration activities is the use of geophysical methods. Large chunks of land were chewed up, tasted, and put aside as unpalatable—for lack of interesting anomalies. While most prospectors are loath to accept geophysics as the last word it seems apparent that without geophysical assurance there is little incentive for drilling. It is a situation which will probably hold true, according to *The Northern Miner*, until more is known of the geology and structure of the Bathurst area.

International Nickel Co. is reported to be back with its airborne magnetometer and has been using the Bathurst airstrip. A private group is also present but the objective is not known.

Another result of the sudden surge and decline of Bathurst interest is the effect on many amateur prospectors who staked out more claims than they could handle. Despite the extension on assessment work requirements, most of them have not been able to do enough to validate their claims. Thus, several old hands are waiting around for the ground to open—with particular claims in mind.


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Drift of Things

WORDS, words, meaningless words. That's all that *profession, organization, society, group, association*, are apt to be unless you get out and see what concrete accomplishments have come from these intangibles in action.

We all know that the basic stimulus for creating the numerous technical associations was to promote the arts and sciences of the respective industries, as well as the welfare of those engaged in the industries. But, often, it is a good idea to take a long hard look at your professional organization and see what its position is with relation to the rest of society.

Only recently, we had occasion to drive from New York to the western line of Ohio. This is certainly no trip of consequence, but the ideas and realizations stimulated by the ride point up that engineering and technical societies are certainly doing a job. This is not always evident to those who are members of the various groups, let alone to those who are not.

It is sometimes difficult to realize that only a few years ago, relatively speaking, a journey from Philadelphia to Pittsburgh was not a short overland haul on the beautiful Pennsylvania Turnpike, but rather a trek requiring several weeks. Now, in an auto, it is a 6-hr trip by a safe trail, free from the hazards of nature. This 328-mile long structure and the apparatus using it, are a monument to all phases of the engineering profession. No group can beat its chest and proclaim: This is ours.

However, we of AIME can cry a bit louder than most. Looking around, while riding along this superhighway, at land transportation only, nothing in sight could be divorced from mining.

Steel and cement, metallics and nonmetallics are major constituents of the roadways, as well as the vehicles operating thereon. Each of these materials, some in large quantities, others in small, originate at a mine and is subjected to various subsequent treatments that are daily topics of AIME members. Beyond that, other specialized sciences in our field, not generally associated with road building, were called upon. Geology and geophysics played a major role in the construction.

It is amazing that our lives become easier, safer (maybe!), and more comfortable at an ever increasing rate. Yet, very few of these steps forward can be isolated from our professional society and the functions it represents. This is a fact that can give great satisfaction.

Now, let's see if the engineering groups are functioning properly and fulfilling their preordained duties. First, examine the modern engineering or science textbook bibliography. This will show that a major portion of the references are publications of some technical organization, and those not now referenced to such a source probably were in the original publication. Investigation will show that very few of the engineering divisions were any more than specialized trades until the advent of societies such as ours over 100 years ago. Textbooks, handbooks, good advice and bad advice, have their origin in the publications of professional societies.

It is illuminating to examine the cause and effect process by which a technical organization produces a science from an empirical situation. A technical man operating in the field often discovers a solution to a problem that he considers applicable only to his own setup. But, with the existence of a technical society, and only with that existence, he is induced to bring his story to the attention of his fellows. Here, others take hold of the limited application and revise it for their own use. Eventually someone becomes curious and asks "Why does this work?" A theory is now evolving from an application.

This process, repeated many times has brought us to the present stage of development of science and technology. Looking back over AIME *Transactions* for the past 84 years will show this even more clearly than it can be described.

The first article of any consequence on the San Manuel Copper Corp. operation at Tiger, Ariz., appears on p. 686 of this issue. This is the first of a series of developments that will, in years to come, add notably to the scope of information in our field. As has happened so many times in the past, and will happen many more times in the future, we have another chapter in the cause-and-effect process carried out by your professional society.

COLLEGE students along with graduates of mining schools have heard their professors expound many times upon the virtue of the profession. Heard frequently is the versatility story: that the mining man is called upon to be an expert in almost every field of engineering. Although it does not necessarily imply engineering, the Associated Press Wire service carried the following:

Officers seized a moonshine whisky still 10 miles northeast of Trinidad in southeastern Colorado, Secretary of State Homer M. Bruce reported.

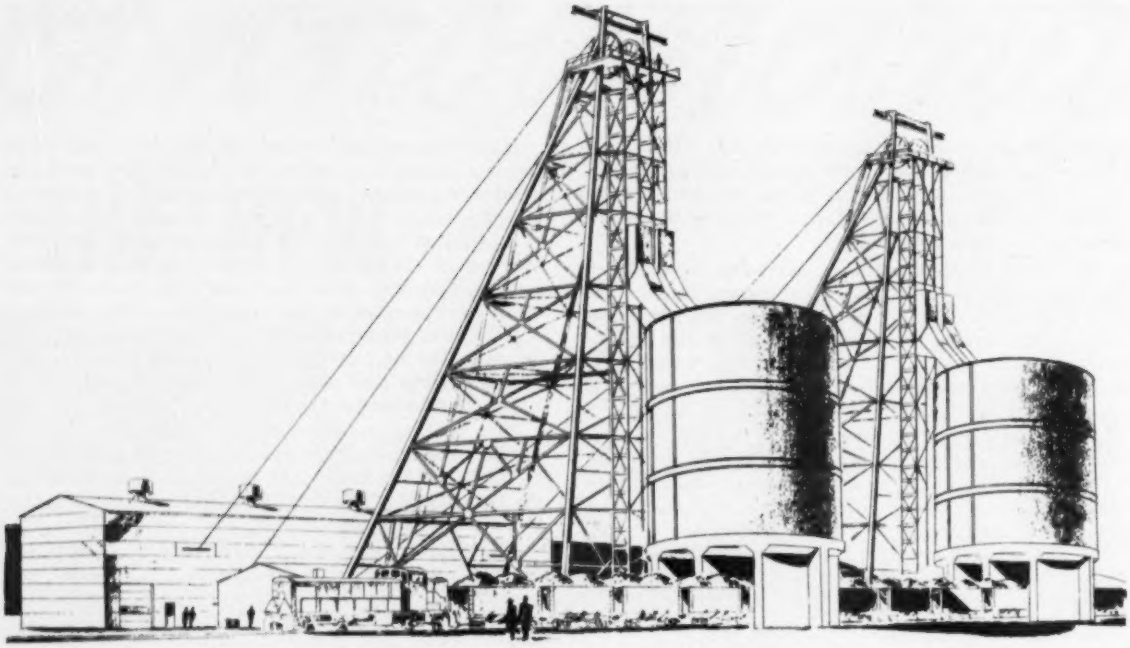
The still, the third found in the state within a month, was discovered in an abandoned clay mine. Bruce said Charles Atkins, 26, a Trinidad coal miner, was arrested.

Mining men really know their business.

IF you still have drilling problems, the September issue of MINING ENGINEERING may hold some of the answers for you. A series of articles covering practices of various mining companies in the U. S. and Canada has evolved into a continuous presentation to give you a picture of up-to-date drilling.

NEW *Yorker* magazine noticed an interesting comment in *The San Francisco Chronicle* which read: "I don't know of any man pulling the trick women pull frequently: getting pregnant by someone of higher social position to force marriage, Rieder asserted." Editors of the *New Yorker* could only say, "Neither do we, by Gad."

Charles M. Cooley



Development of the San Manuel

Five shafts—two down and three to go—provide hoisting, ventilation, and supply access for future biggest underground operation. Twin No. 3 shafts will handle 35,000 tpd of copper ore. No. 4 shaft will be main source of supply for underground.

PLANS for development of the San Manuel orebody have been worked out and are progressing parallel with construction of the surface plant. This property lies in the Old Hat mining district, Pinal County, Ariz., about a mile south of Tiger where the St. Anthony mine once produced gold, molybdenum, vanadium, lead, and zinc.

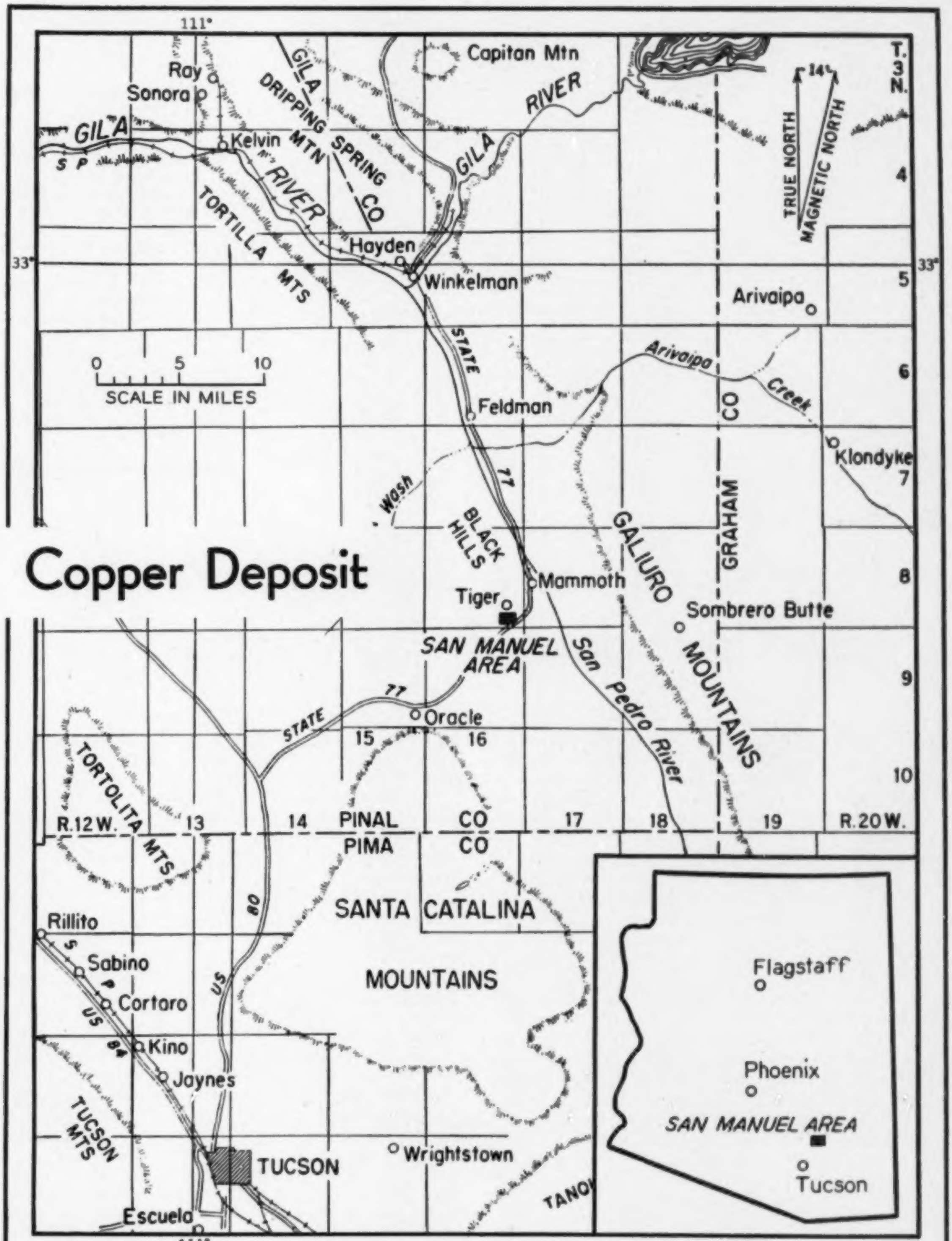
Two development shafts have been completed and serve as ingress for preparation of the 1475 haulage level and 1415 grizzly level. Three other shafts are being put down. The Nos. 3A and 3B shafts will provide the ore hoisting facilities. The No. 4 shaft, now being sunk, will be at the main mine service and supply yard, with primary function to provide the mine with supplies.

The general exploitation plan for the orebody calls for block caving, a scheme widely used for massive, low grade orebodies. At San Manuel the first haulage level has been established at the 1475-ft level and will develop the South orebody. A grizzly level 60 ft above the haulage level is connected with the shafts for service. A transfer raise system will carry rock to the haulage level, but exact details of the grizzly chambers and ore handling on this level are not yet available.

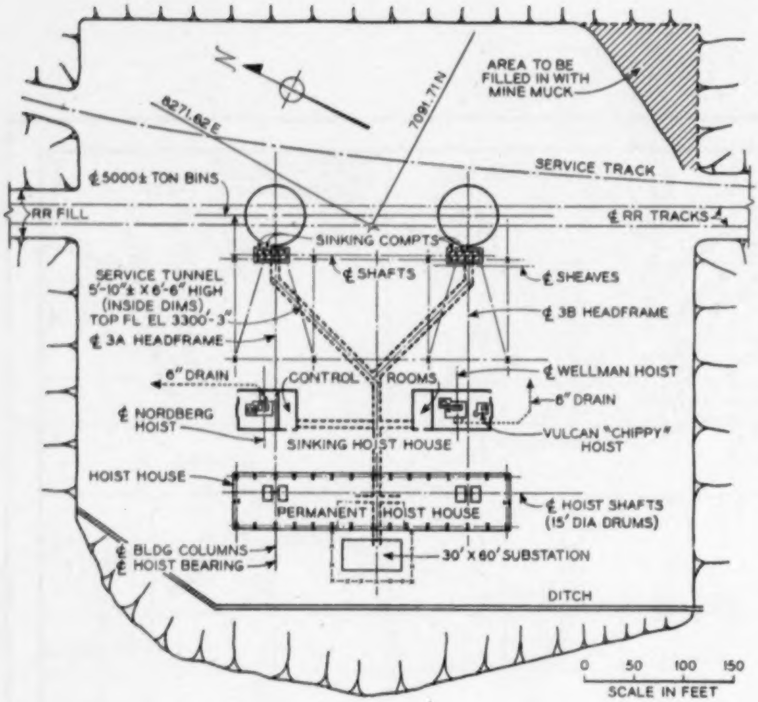
Location of the first caving lift will bring into production the upper one third of the orebody, measured vertically. This is the upper third in vertical dimension only, since it is probable that the second level will create the largest ore tonnage.

Great interest in the mining industry attaches to the details of the shaft sinking and drifting to develop an underground operation scheduled for 35,000-ton daily output. Two men from the San Manuel organization present the data and important facts behind the work now in progress—behind the beginnings of a plant that will eventually exceed the record of the Climax molybdenum operation in Colorado, which is now North America's largest underground mine.

Copper Deposit



After USGS Prof. Paper No. 256



Completed No. 3B headframe is now atop shaft down more than 550 ft. Hoisthouse and substation are on right and the 3A headframe with its sinking hoist is shown under construction on the left.

Layout shows arrangements for the twin ore hoisting shafts. Each of the No. 3 shafts is set up as an individual unit capable of handling half the mine production. Permanent hoist, to go in at end of sinking job, will have more horsepower than any now in use. A concreted service tunnel, similar to those used at recent iron country installations, will provide access to manway compartment of each shaft and house all pipe lines, power lines, and signal circuits. Permanent headframe has 181-ft A-frame structure; sinking hoist is using temporary sheave 90 ft high.

San Manuel —

Progress on Three Big Shafts Reveals Up-to-date Sinking Practice

by C. L. Pillar

TWO shafts have been completed since the spring of 1948 when underground development started, and three are now under construction. The new program provides two main ore shafts, Nos. 3A and 3B, spaced 195 ft apart and located on the southwestern end of the orebody. It is planned that eventually 35,000 tons of copper ore per day will be hoisted by these identical four-compartment shafts.

The third shaft of this new group is 600 ft from the present No. 1 shaft and will provide caged supplies for the underground mining operations. This No. 4 shaft has the largest cross-section of any shaft in Arizona.

Ventilation will be established so as to make the No. 4 shaft downcast, carrying 300,000 cfm, while the twin No. 3 shafts will exhaust 400,000 cfm. The 100,000 cfm deficiency in fresh air coming down No. 4 shaft will be made up by No. 1 shaft. No. 2 shaft will be neutral.

Shafts Nos. 3A and 3B will be the primary hoisting facilities. The two openings, separated by a 165-ft pillar, are identical in size and hoisting equipment. Each has four 6½x7-ft compartments, requiring a 9ft2in.x31ft6in. rock excavation. Each shaft is set up as an individual unit capable of handling half of the mine production, each having two 18-ton bottom-dump skips operating in balance at a rope speed of 3000 fpm. The installation is designed to deliver 860 tph from a maximum depth of 3000 ft, the proposed bottom level of the mine.

The permanent ore hoist will be installed at the end of the sinking period and will have more connected horsepower than any hoist now in use. The double cylindrical drum (15-ft diam x 116-in. face accommodating 3000 ft of 2¼-in. wire rope) will be driven by two 3000-hp dc motors. A 4000-hp ac induction motor will drive two 2500-kw generators with flywheel for 80 pct power peak equalization to provide dc current for the hoist.

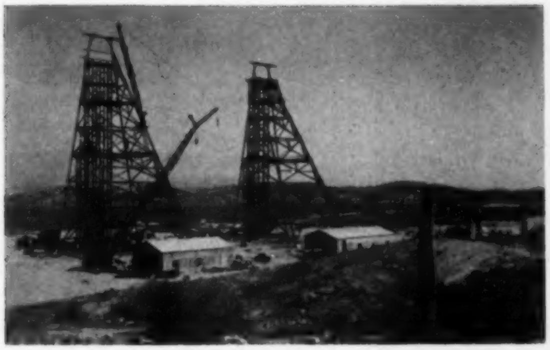
Ore hoists will be semiautomatic; i.e., the skip tender at the underground loading pocket will operate the hoist by push button. When the skip is loaded, he will start the hoist which will go through the cycle automatically until the skip comes to rest in dumping position in the headframe. At this point, the other skip is spotted for loading at the underground station.

The compartment between the two skipways will serve as the manway, and for ladders, piping, and power cables. In the first compartment, an auxiliary cage will be installed to handle men and supplies, as well as shaft cleanup.

A 6½x5-ft concrete service tunnel enters the manway compartment of each shaft 10 ft below the surface. The tunnels extend in a "Y" from each

C. L. PILLAR is Development Superintendent, San Manuel Copper Corp., Tiger, Ariz.

Yellow indicates outline of orebody



shaft through the center of the permanent hoisthouse to the electric substation, housing all pipe lines, power lines, signal and control circuits that will go down the shafts.

Shaft Sinking

Located outside the orebody so as to be clear of any subsidence caused by mining, the two No. 3 shafts are being sunk in the Gila conglomerate. Excavation will be terminated at 1750 ft, but some years from now it will be necessary to increase the depth for the next mining level. Two permanent stations will be at the 1415 and 1475-ft levels, the upper one being primarily for exhausting air from the mine into the shafts and the lower station will serve as an access for men and supplies on the haulage. The 275-ft sump below the 1475 will provide space for skip loading, sump pumps, and future shaft sinking operations. No. 3B shaft will have four temporary booster pump station excavations at 315, 615, 915, and 1215 ft below the shaft collar. These pump stations are for sinking operations.

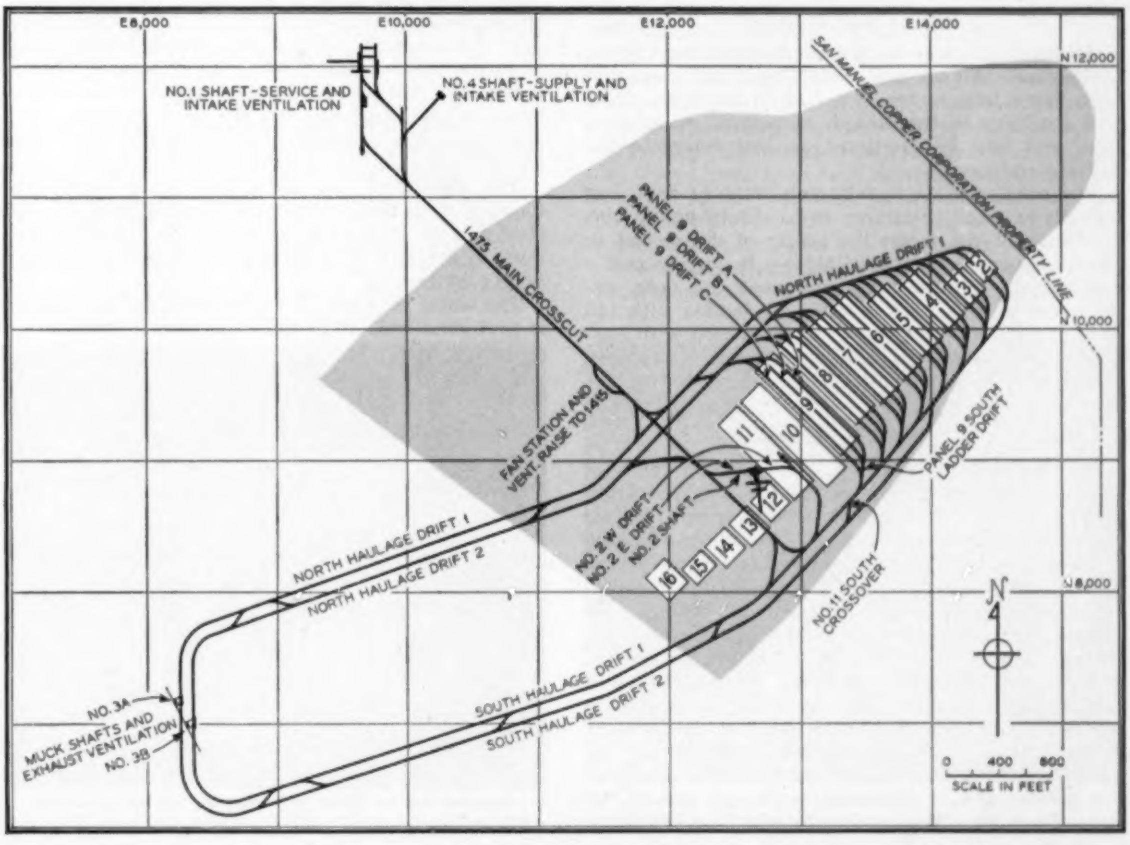
Shaft excavation utilizes the permanent headframes, which are conventional steel A-frame type 181-ft high. Sinking sheaves have been placed 90 ft above the collars and 180-ton temporary bins are built into the structure. At the end of the sinking period, a 5000-ton ore bin will be erected at each shaft and permanent sheaves installed on top of the headframes.

The shaft collars were installed by excavating 25 ft of unsupported raw shaft with a clamshell. Five 12-in. WF 64-lb bearer beams, 36-ft long, were placed across the top of the shaft at the collar elevation. These were included in the collar fabrication and supported the sets hung immediately below. After placing the collar concrete, the extended ends of the bearer beams were cut off flush with the outside of the concrete shaft walls.

It was found advantageous to place the Riddell mucker in the shafts as soon as possible. In both cases the mucker was installed when the shafts were at 25 ft, placing the track and running gear on the second set and using the crane to hoist a 2-ton bucket. The remainder of the collar excavation and concreting procedure was typical of the sinking operation. No. 3B shaft is down 550 ft and 3A, the last to be collared, is at the 375-ft level.

Sinking Crew

Each shaft requires a crew of six men per shift in the bottom for drilling, mucking, placing steel, concreting, installing manway and service lines on contract. A top lander, truck driver, and hoistman will provide the necessary surface service for each shift.



Crew shown here (shaft men, top lander, hoist men, and truck drivers for all three shifts, with supervisory personnel) is believed to be setting a record with large No. 4 shaft. Despite size of 400-sq ft rock excavation, "finished shaft" is being put down at rate of better than 5 ft per 24 hr.

In order to better coordinate the surface service with the crew on the bottom, a two-way blastproof loudspeaker system is installed to allow the shaft crew to talk with the surface operators.

Sinking Hoists

Sinking hoists for both shafts are double-drum clutched hoists driven by a 250-hp motor, with 15,000-lb rope pull and 850 fpm hoisting speed. A 1500-lb crosshead is attached to each rope, and a 38-cu ft sinking bucket hooked 6 ft under the crosshead. The sinking hoists will operate in the first and second compartments of each shaft. The fourth compartment of No. 3B will be serviced by a 100-hp single-drum hoist to handle the sinking pump gear.

Drilling and Blasting

All drilling is with hand-held Jackhammers of the 55-lb class. An air and water manifold, equipped with line oilers, serves as a rack to carry the drills and auxiliary to the bottom as a unit. Alloy drill steel and one-use friction-type bits complete the drilling equipment.

The conglomerate is relatively easy to drill, but difficult to break. Fourteen rows of four holes, with a relieved V-cut across the center of the second or third compartment, are drilled 6½ ft deep to pull a 6-ft round. To date little overbreak has been experienced on the sides. Rounds are loaded with 125 lb of straight 40 pct gelatin and detonated with regular-delay electric blasting caps. Loading has been one stick of powder per ft of hole with a 2½ to 3-ft burden.

Shaft Mucking

A Riddell shaft mucker, with counterweighted ⅜-cu yd clamshell, handles the mucking operation in both shafts. The mucking track has been set on the steel sets, covering the first three compartments. Dividers are left out of the steel sets beneath the mucker and are placed after the machine is lowered, which is every three or four sets under normal conditions. The rock has been good and can stand unsupported for 20 to 30 ft. In the event the ground does require support close to the bottom the track will be cut to the two center sets and the full steel set will be placed minus the No. 2 divider. Good operators can reach the end compartments by the swinging of the clam. However, the open sump at the bottom allows freer, more efficient use of the Riddell mucker. The last few tons of loose muck are either hand-loaded or left in the center. The entire crew is used in the mucking cycle.

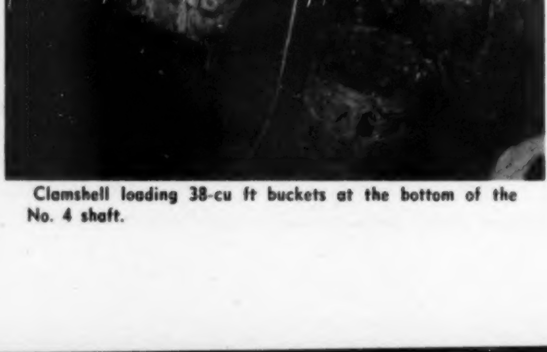
Muck is hoisted to the surface bin in 38-cu ft buckets. The bucket dumps consist of an underslung car moved in and out of the shaft by an air cylinder with a conventional keyhole slot and slide to overturn the bucket with the tail chain. This car completely covers one compartment of the shaft while the bucket is dumping. The complete surface operation, including setting the crosshead on the dumping chairs, is controlled by the top lander.

Ground Support

Steel sets on 6-ft centers set in a minimum of 12 in. of reinforced concrete provide ground support. Concrete is positioned 6 in. inside the shaft steel. Reinforced concrete curtain walls, 12 in. thick, support the shaft at the dividers. These shafts differ from the earlier ones in that the structural steel is incased in reinforced concrete except where guide brackets are attached. This will give strength, prevent excessive corrosion, and streamline the shaft for the large volume of exhaust air.

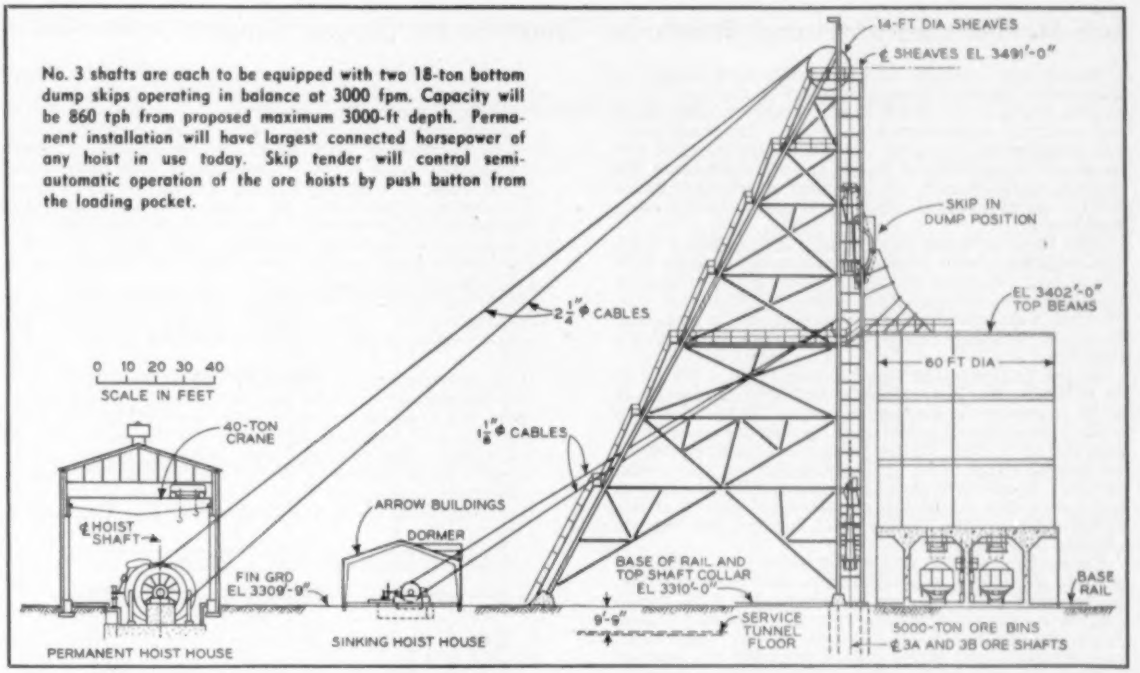
The steel sets are hung first, then lined and blocked with temporary 2-in. lagging between the steel and the rock where required. Past practice has been to support 48 to 60 ft of shaft in this manner before concreting.

The water that will be encountered in these shafts is problematical. It has been estimated that water



Clamshell loading 38-cu ft buckets at the bottom of the No. 4 shaft.

No. 3 shafts are each to be equipped with two 18-ton bottom dump skips operating in balance at 3000 fpm. Capacity will be 860 tph from proposed maximum 3000-ft depth. Permanent installation will have largest connected horsepower of any hoist in use today. Skip tender will control semi-automatic operation of the ore hoists by push button from the loading pocket.



will be encountered in the Gila conglomerate at a depth of 300 to 350 ft. This is based on water table data from churn drill holes in the surrounding area. On the basis of this data and conditions encountered in other shafts, the maximum inflow in Nos. 3A and 3B would be estimated at 1000 to 1500 gpm at 1750-ft depth. By keeping No. 3B shaft about 200 ft ahead of the 3A shaft, the heavy pumping in the area can be accomplished through one shaft equipped with an additional auxiliary pump hoist.

Pumping Shaft Water

First water encountered will be handled in the bottom by an eight-stage deep-well type pump with 440-v, 1750-rpm, 75-hp motor, having a rated capacity of 500 gpm at 420 ft. This unit is close coupled, 14 ft long and weighs 4000 lb. Similar units handled the water in the bottom of No. 1 and No. 2 shafts successfully during their sinking operations. The pump will be connected to an 8-in. discharge line by a 50-ft length of high-pressure hose.

A booster station will be cut in the neighborhood of 315-ft depth to provide for pumps to relay the discharge to the surface. Provision will be made for four 100-hp, 440-v, 3600-rpm, single-stage centrifugal pumps rated at 600 gpm at 425-ft head with four 500-gal surge tanks to feed the booster pumps. Pumps are operated automatically by float switches.

Additional booster stations will be placed at 300-ft intervals as the sinking progresses.

The sinker-pump discharge goes through 12-in. cyclone desanding cones in parallel before emptying into the 500-gal surge tanks at the booster pump station. The desanding cyclone is a new addition to shaft pumping procedures and somewhat of a guinea pig. Its purpose is to take most of the coarse sand from the sinker discharge before it is run through the booster pumps, thus eliminating in part the excessive maintenance on this equipment.

When pumps are placed at the 1215 and 1475-ft stations, a 2300-v feeder line will be brought to the

(Continued on page 694)

LEFT: Bucket of muck is being hoisted past Riddell mucker. RIGHT: Looking down on twin Riddell shaft muckers operating 30 ft above bottom of No. 4 shaft. Same setup is used in No. 3 shafts, except that smaller section only requires one machine.

San Manuel uses Steel and Reinforced Concrete for Ground Support

Reinforced concrete and steel sets on 6-ft centers provide permanent ground support in the new No. 3 shafts. A minimum of 12 in. of concrete is used, with the concrete positioned 6 in. within the shaft steel, and reinforced concrete curtain walls support the shaft at the dividers. A 3x4-ft arched window in the curtain walls of each set provides attachment space for the guide brackets and for access between compartments.

The steel is hung first, lined and blocked with 2-in. lagging where required, before concreting. Sets are of 6-in., 25-lb, H-beam end plates and wall plates. Dividers are 11½-in. box beams built up of two vertical 6-in. channels and ⅜x4-in. plate straping. Each set is hung from ten 3½x3½x5/16-in. angle studdles.

At the beginning of the concrete cycle a set, 48 to 60 ft below the last concrete and approximately 18 to 30 ft above the bottom, is sealed off and the concrete placed back up the shaft to the previous pour, one set at a time. Reinforcing steel is made up of horizontal rings of ¾-in. rods on 6-in. centers with vertical ¾-in. rods on 12-in. centers. Reinforcing is welded on the surface in panels, a practice that has saved time on the bottom and insures the correct placing of the bars.

Forms for concreting are comparable to steel lagging 14 in. wide and weighing 90 lbs. They are supported and held in place vertically by 6-in. flange walers supported from the dividers and end plates. Each compartment is formed on all four sides with special steel arch forms bolted between the curtain wall panels and on the outside of the end wall panels to form the necessary windows and recesses for the guide brackets. Form panels are bolted together with speed bolts, blocked in place against the inside flange of the walers, and the concrete side of the forms are brushed with oil prior to pouring. Main forms are stripped after 24 hr and used on the sets above with the exception of the window and end wall recess forms. These are left in place for a minimum of 7 days.

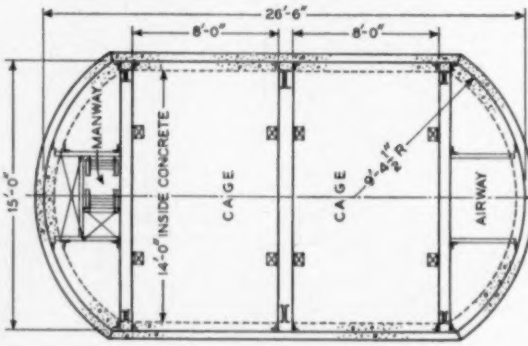
The concrete is a 1:2:4 mix of cement, screened river sand, and crushed rock with the addition of pozzolana to give high early strength. Mix is fed to a ½-cu yd mixer at the shaft collar from a 40-ton batch plant and concrete drops through an 8-in. pipe into a small bottom gate hopper just above the pouring floor in the shaft. Small rubber tired buggies are loaded from the hopper and dumped into the forms. This method of placing the concrete cuts down on aggregate segregation and brings the pour up evenly in the forms. The seven-man shaft crew can place the concrete in the forms as rapidly as it can be mixed properly. The concrete is vibrated in the forms by compressed air vibrators.

When water is encountered in these shafts the placing of good concrete becomes considerably more difficult. Best results under heavy water conditions in No. 1 shaft were obtained by making the forms watertight and allowing the collected water to overflow the forms. This meant the concrete was placed under water and the excessive water was displaced and overflowed. This procedure carries some cement and fines with it, but considerably less than when the water is washing through the forms. In pouring under wet conditions the cement in the mix is increased 50 pct to offset the overflow loss. Test cylinders averaged approximately 3000 psi in dry zones and the same under wet conditions when proper precautions are taken.

Weep holes are drilled in side walls of each compartment on 12-ft vertical spacing to relieve the hydrostatic pressure in water-bearing ground.

No. 4 Shaft

Ground support for the No. 4 shaft differs from the No. 3 in that curtain walls are omitted, and reinforced concrete is used only on the perimeter of the shaft. The steel sets have wall and end plates of 6-in., 25-lb H-beams with 8-in., 31-lb WF beam dividers across the width of the shaft at the ends and 8x10-in. 39-lb WF beams through the center.



Typical section in the No. 4 shaft.

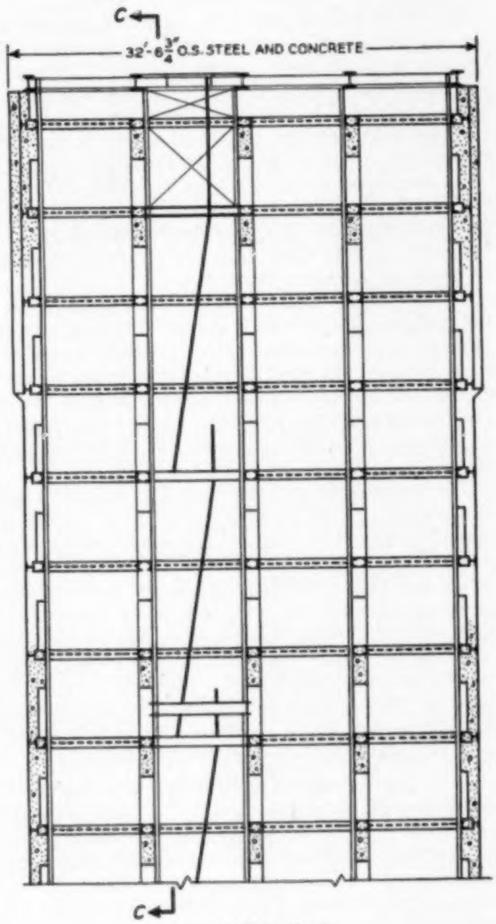
Dividers are supported on each end by posts of heavy channel placed back to back. The center dividers have an additional 8-in., 15-lb post at the center to give additional strength. This heavy posting of the dividers is to give strength across the 14-ft span to maintain alignment of the four cage guides. Each set is hung from fourteen 3½x3½x5/16-in. angle studdles.

The concrete line is 6 in. inside the steel allowing a minimum of 12 in. of concrete. The forming and placing procedure is similar to that used at No. 3 shafts. It is simpler and faster than the No. 3 process due to the absence of curtain walls.

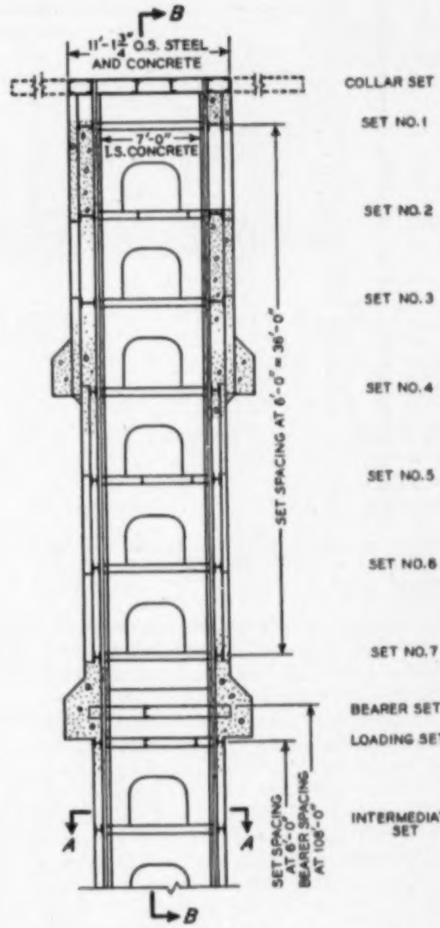
No. 4 SHAFT: Headframe, sinking hoisthouse, temporary muck bins, and concrete plant are shown here.

TWIN MUCKERS: Double clamshells serve the No. 4 shaft, where sufficient space makes possible use of two machines.

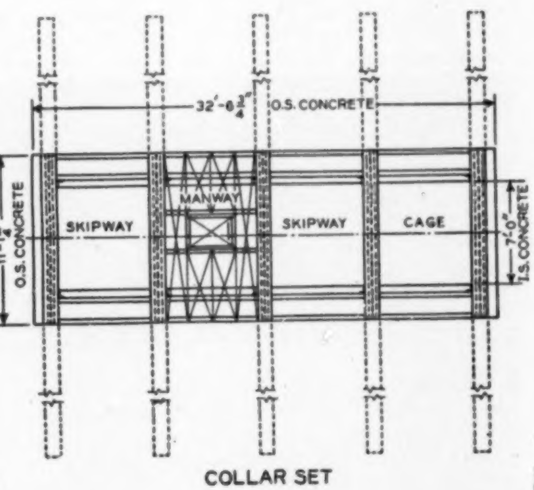
Design of Steel and Concrete for No. 3 Shafts



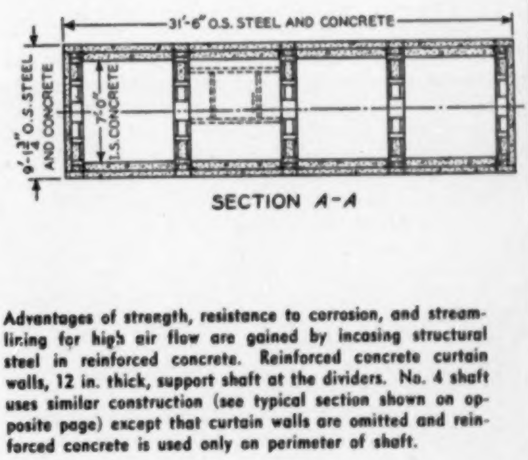
SECTION B-B



SECTION C-C

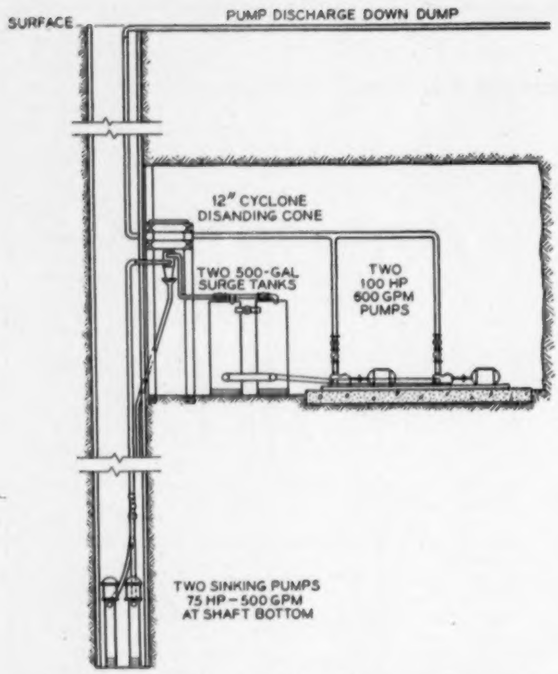


COLLAR SET



SECTION A-A

Advantages of strength, resistance to corrosion, and streamlining for high air flow are gained by incasing structural steel in reinforced concrete. Reinforced concrete curtain walls, 12 in. thick, support shaft at the dividers. No. 4 shaft uses similar construction (see typical section shown on opposite page) except that curtain walls are omitted and reinforced concrete is used only on perimeter of shaft.



Desanding cyclone is on trial in effort to remove coarse material from sinker pump discharge before it goes to booster pumps.

1215 together with required transformer capacity to handle 440-v power there and below. New air-cooled transformer units will be used for this temporary power installation.

In order that large quantities of water will not fall free in the shaft over vertical distances in excess of 50 ft, water rings are formed by leaving the concrete lining out for a vertical distance of 2 ft below the concrete seal-off sets which are spaced approximately 48 ft apart. A headboard around the bottom of this recess will form a ditch 18x12 in. around the perimeter of the shaft. This ditch traps most of the water falling down the shaft walls from the weep holes and leakage through the concrete above. A 300-gpm motor pump, set below the ring and fed by gravity from it, discharges the water into the sinker columns.

As the upper rings dry up with the shaft advance, the water-ring pumps will be moved to a lower ring. It will also be possible to connect two or more rings together in order to concentrate water in the lower rings for pumping. The water rings improve the working conditions at the bottom of the shaft and keep the load on the sinker pumps down.

Past experience has been that a sinker-pump in good condition will lift 500 gpm of clear water 400 ft, but drops off to 350 gpm after handling quantities of dirty water during the mucking operation. The wear and maintenance on the sinker pumps will be high. Past experience has shown the life of a sinker pump before overhaul will be about 48 ft of shaft excavation and concrete work.

Two sinker pumps can be accommodated on the bottom where necessary but it is preferable to trap as much water as possible before it gets to the bottom.

Sinking operations are ventilated by fresh air carried down in 24-in. light-walled vent pipe, the discharge of which is usually kept at the bottom of the shaft concrete. One 7½-hp, 440-v, axial vane fan, rated at 7000 cfm under 4 in. of water gage ventilates each shaft. Past experience has shown that after shafts become wet, the fans are required only after blasting.

No. 4 Supply Shaft

The new service shaft, to be the principal access for mining supplies and equipment on the 1415 and 1475-ft levels, is being excavated 600 ft from the No. 1 shaft on the northwest side of the ore zone. The cross-section is basically a 15x17-ft rectangle with circular segments on the 15-ft ends. Rock excavation for the shaft measures 16 ftx27 ft 6 in. giving a cross-sectional area of 400 sq ft. This will provide for two 8x14-ft cage compartments and two circular segments on each end, one for the manway and the other to provide additional area for the 300,000 cfm of fresh air entering the mine.

The finished shaft will be equipped with two 6½x13½-ft double-deck supply cages operating in balance at a rope speed of 1500 fpm. The cages will each handle 100 men, an 8-ton development locomotive, or two loaded 11-ft timber trucks. All portable underground equipment can be caged with the exception of the main haulage locomotives and ore cars.

The permanent service hoist that will be installed at the end of the sinking period is a double-drum machine powered by two 700-hp, 600-v motors. Each of the cylindrical drums (15-ft diam x 90-in. face) will wind 3000 ft of 2¼-in. wire rope. The motor-generator set for hoist power is a 1750-hp synchronous motor driving two 600-kw generators.

As in the No. 3 installation, a 6½x5-ft concrete service tunnel connects the manway end of No. 4 shaft with the hoist house and electric substation. Similar to the No. 3 installation, it will house all pipe and electric lines entering the shaft.

Rapid Progress in Sinking No. 4 Shaft

Present plans are to sink No. 4 service shaft to a depth of 1550 ft in relatively dry, blocky quartz monzonite. Cutouts for the three main shaft stations will be made by the sinking crews. The first will be at the 1350-ft level which will be the main takeoff for the incoming fresh air, thereby keeping it away from the lower supply stations located on the 1415 and 1475-ft levels. A 75-ft sump below the 1475 will permit pump installations and leave space for future sinking. The No. 4 shaft is now down 900 ft, and the last 700 ft of progress was at the rate of 5 ft per day.

In general the methods and equipment utilized in the No. 3 shafts are being followed in sinking No. 4 shaft. Drilling operation differs because the larger excavation area requires 72 drill holes. Twelve rows of six holes are used with a conventional V-cut across the center of one of the cage compartments. Approximately 125 lb of powder is used on a 6-ft round. The altered quartz monzonite breaks and pulls with greater ease than the tougher conglomerate at No. 3, but also presents more of a problem in overbreak.

The size of No. 4 shaft makes the use of two identical Riddell shaft mucking units advantageous. Each mucker loads a bucket working in its compartment. Hoisting during the mucking cycle is in balance with the exception of dumping in the headframe and moving the lower bucket from its hang-up point to the bottom of the shaft.

The ground in No. 4 shaft requires immediate

support within 12 to 20 ft of the bottom. This is accomplished with the regular steel sets and 2-in. lagging.

The ground support, as in the No. 3 shafts, is composed of steel sets on 6-ft centers set in 12 in. of heavily reinforced concrete. Here reinforced concrete is used only on the perimeter of the shaft, without curtain walls.

Since No. 4 shaft is being sunk 600 ft from No. 1 shaft, which is 1643 ft deep and has been draining this area for the past two years, no appreciable amount of water is expected in the sinking of No. 4.

Drifts on the 1415 and 1475 levels will be under No. 4 shaft shortly, which should complete the drainage of this area in time for No. 4 to be sunk dry. In the event some water is encountered, it can be drained by diamond drill holes to the 1415 level.

The author wishes to acknowledge the assistance and cooperation received from J. F. Buchanan, L. I. VanDalsem, members of the San Manuel Copper Corp. and Stearns Rogers engineering staffs, in the preparation of this paper.

San Manuel

Drifting Opens Huge Orebody for Block Caving

by H. I. Ashby

INITIAL development of the south orebody at San Manuel is being carried out from the No. 1 and No. 2 shafts. The haulage and grizzly levels are being driven to develop the upper one third of the massive hydrothermally altered and fractured monzonite orebody. This first haulage level has been placed at the 1475-ft level with a grizzly level 60 ft above. The grizzly level will be connected to all service shafts so that men and supplies can come down to the grizzly level and go to working places without congesting the haulage level. These connections are also a vital part of the ventilation plan.

The haulage level is being advanced along the north and south fringes of the orebody and connections are being driven to the three shafts now under construction. The No. 1 and No. 2 shafts will serve the development work with supplies, skip hoisting, and ventilation at each shaft and the two shafts are connected on both the grizzly and haulage level.

Drift Crews

Five crews are driving haulage drifts and three more crews are driving grizzly drifts. During the month of October 1953 these drift crews made 2615 ft of advance for an average of 327 ft per crew. Each crew is made up of four men: a leadman, two miners, and a mucker. On a 7-day week each man has a different day off and his place is filled by the replacement from the labor gang. Crews work on a bonus system that requires them to drill, blast, muck, timber, lay track, and handle flexible vent tubes. Air and water lines as well as rigid ventilation pipes are installed by the labor crew. The bonus system is so set up that a 4-man crew that completes a cycle of operations in a shift will make between \$6 and \$7 bonus per shift.

Equipment

Each of these drift headings requires an 8-ton battery locomotive, eight 5-ton bottom-dump gondolas, and a flatcar. The crews also have a rocker-type loader and jumbo with two booms. The booms are operated by air vane motors, locked with air brakes, and each boom carries a 3-in. drifter mounted on a 6-ft aluminum shell. For drilling, regular 1-in. quarter-octagon drill steel is used.

Early in the drifting program it was found that steel breakage was only about 50 pct as much with this section as it was with 1⅛-in. round steel. The

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Fractured and altered rock requires booms and placement of lagging to catch back before mucking out.

After muck is cleaned out posts are stood under boomed caps. Timber interval of 5 ft regulates rate of advance.

drifters in use are equipped with Jackhammer type front heads and steel pullers. The use of 1-in. quarter-octagon has brought additional advantages since it is standard for sinker and stoper drills and reduces drill steel inventory. One-use friction bits are regular equipment. The common size bit for drifting is 1⅝ in.

Three-shift operation without a blasting schedule makes good ventilation essential to the health of the miners. Prior to making a connection between the two shafts, regular sinking fans were used for ventilation with 7½-hp axial-flow fans in series along the ventline to maintain adequate air flow. A 24-in. thin wall metal pipe duct carries air to the faces. Booster fans are modified in the shop to couple into the line with regular pipe fittings. At first a 50-hp fan at the collar of No. 2 shaft and a 20-hp fan at the collar of No. 1 shaft supplied the underground workings with fresh air. After the two shafts were connected, a fan drift was driven off the main crosscut for the installation of a 200-hp axial-flow fan. An airlock, with electrically controlled doors, controls ventilation in the haulage level main crosscut and a similar arrangement is to be placed in the grizzly level. With these doors the main air stream is made to flow through one of the panel drifts and back along the south haulage fringes to No. 2 shaft. Through a raise from the fan drift to the grizzly level, part of the air is led back along the grizzly main crosscut to both No. 1 and No. 2 shafts. From this main air stream, booster fans carry the air into the operating faces.

Ground Support

The rock at San Manuel is so fractured and altered that all drifts are timbered and side lagged. Booms are required and the cap and back lagging are put up before mucking out a round. If the ground is particularly weak, the back is timbered immediately after the blast, but usually four or five cars can be taken out before booming the cap and lagging the back. Then the rest of the round is cleaned out and the posts positioned.

The timber interval is 5 ft and no attempt is made to break past the set interval with a round. With long-feed drifters, a round can be drilled out with one piece of steel. This decreases the drilling time considerably, but limits the type of cut that can be used for the round. A horizontal V-cut is used at present.

When advancing, a cut out for car transfer is made about every 400 ft. A horizontal car transfer is used and has given satisfactory service. It has been determined that 400 ft is the maximum distance that a train crew can handle empty cars and not make the loading machine wait. When abandoned for car transfer, these wide areas in the drift can be used to advantage for timber storage, as transformer substations, and as sanitation stations.

Blasting

Electrical primers are used in wet areas and fused primers in dry locations with 40 pct straight gelatine dynamite in all headings. For electric blasting a 440-v circuit is carried from the nearest transformer station to a locked switch located in a convenient place at least 500 ft from the face.Fuse primer procedure is the standard practice with spitter cord connectors on the end of 8-ft fuses. The sequence in which the connectors are clamped on the spitter cord determines the timing of the round.

Three types of drifts are being driven: haulage, grizzly fringe, and grizzly panel drifts. Haulage drifts are timbered with a 10-ft cap and 10 ft 5-in. post. Most of the timber is 12x12 in. but 10x12-in. timber is used in some of the less altered zones. Haulage drift track is 36-in. gage and 45-lb rail is used while driving. The present track installation is not intended to be the production railroad, which will be installed later. During this development period the track is placed 1 ft below final drift grade.

Track will be raised later and sufficient ballast added to make a good roadbed. Ballast will be brought into the mine because the mine rock is badly altered and unsatisfactory for track use.

Grizzly fringe drifts are timbered with 10-ft caps and 9 ft 5-in. posts. The track in this drift is carried only a few inches below grade. Grizzly panel drifts are timbered with 8-ft caps and 8 ft 5-in. posts. All grizzly drifts use 12x12-in. timber and are side lined.

On the haulage level all turnouts will have 165-ft radius and no curves will have less than 150-ft radius. Turnouts are cut out as the drift is driven. Turnout caps are made from 12x12-in. WF beams with a 10x12-in. timber bridged cap. The steel rests on regular drift posts.

Geology of the Deposit

THE OREBODY IS CHALCOPYRITE AND PYRITE disseminated through quartz monzonite, monzonite porphyry, and diabase. Although the ore zone has been outlined by drilling, the copper content seems to grade out above and below, except at the outcrop or the contact with the conglomerate. The San Manuel Copper Corp. has adopted 0.5 pct copper as the economic limits of the orebody. The known size of the deposit has been established as 6800 ft long and in the eastern area the maximum width is more than 3000 ft.

Supergene oxidation and enrichment of the ore have been extensive. The present water table ranges from 300 to 800 ft below the surface, but these levels are being altered by shafts and other openings. Depth of oxidation varies from 285 to 1600 ft over the area.

Chrysocolla is the predominant copper mineral in the oxidized zone. The copper appears to have been diminished and redistributed by leaching, but the average copper assay in this portion of the orebody averages about 0.75 pct. An irregular supergene sulphide zone is present below the oxidized mineral, where percolating solutions have deposited chalcocite and other secondary copper sulphides as replacements of primary pyrite and chalcopyrite. The zone of enrichment is not a single, simple zone, for oxidized areas occur within it, and, locally, secondary minerals occur with primary sulphides in patches above and below.

Molybdenite occurrence is widespread but small in amounts. Present plans are to recover the 0.02 pct MoS_2 in the concentrator. The mineral is rarely seen in the drill cuttings but shows up in concentrates as small flakes.

The estimate of reserves indicated that the extent of the orebody is tremendous. According to figures published by the San Manuel Copper Corp., the total is 462 million tons, of which 339 million tons is classified as sulphide ore with a copper content of 0.789 pct, and 123 million tons as oxidized ore containing 0.767 pct copper.

Boulder Batholith —

Potential Montana Uranium Province

by Ernest E. Thurlow and Leonard D. Jarrard

THE Boulder batholith of western Montana may be considered a uranium province: a regional geologic environment within which uranium is found in uncommon amounts. Reconnaissance examinations indicated that the Atomic Energy Commission should undertake an evaluation of the potential of this area for uranium production. The AEC has been assisted by the U. S. Geological Survey which has given priority to selected uranium-bearing areas in overall studies of the mineral deposits of the batholith and adjacent regions. Although no outstanding uranium deposits have been discovered, uranium ore has been produced from three widely separated deposits upon which most of the exploration to date has been directed.

The intrusive mass referred to as the Boulder batholith occupies a strip of mountainous country about 18 miles wide between Butte and Helena, Mont., covering an area of approximately 1000 sq miles. Elevations range from 3500 ft along Prickly Pear Creek to nearly 9000 ft near Elkhorn Peak a few miles to the east. Except for a few flat-lying valley lands, the region is wooded with lodgepole pine and fir. Though mainly dependent upon mining ventures in the past, the area now is supported, outside of the Butte district, almost wholly by agriculture and some lumbering.

Geologic Setting

Quartz-monzonite, locally termed Butte granite, is the main constituent of the batholith which is generally considered to be early Tertiary in age. Remnants of older (Cretaceous) volcanic rocks are found in many parts of the batholith. The quartz-monzonite is host to many later dikes and locally is covered by rhyolitic extrusives. In a few areas, what appear to be late magmatic differentiates form dikes and irregular masses of granitic composition and varying textures. These rock types are of particular interest because the so-called *siliceous reef* type of uranium deposit is rather intimately associated with them.

The geologic environment of these deposits is somewhat similar to that of the productive uranium deposits of north-central Portugal. However, the granitic host rock in Portugal is considered to be late Paleozoic in age. Like the Montana deposits, those of Portugal predominately occupy a series of steeply dipping northeasterly trending shear or fracture zones occurring in association with a set of essentially north-south veins. The deposits are similar mineralogically and are enclosed in essentially the same type and pattern of wall rock alteration.

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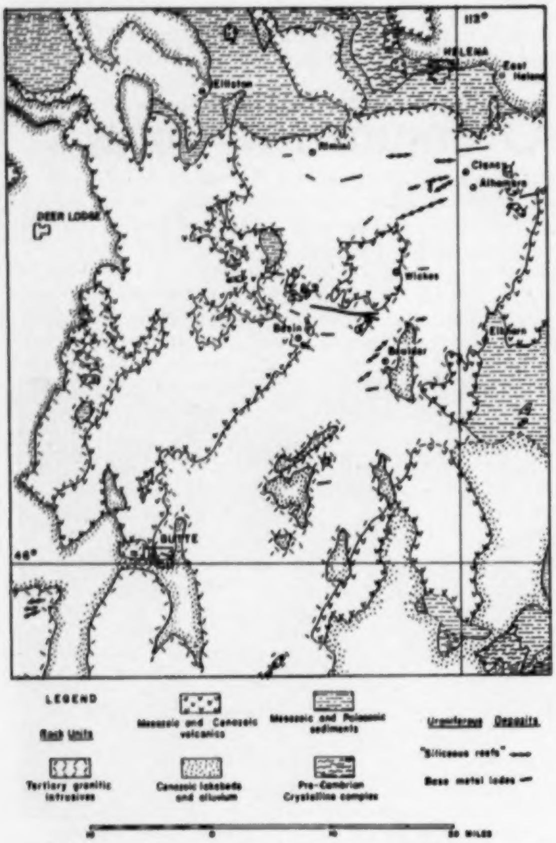
Siliceous reefs, like this one in the central Boulder batholith, have had several closely associated uranium deposits. Deposits occurred as pods measuring tens of feet and scattered along the dip and strike of the reefs.

The ore deposits of the Boulder batholith have been variously classified by relative age, genetic relationship with intrusives and extrusives, and mineralogy or metal content. A simple classification proposed by Knopf, dividing the deposits into an older and a younger group, is used here. Both groups include silver-lead and gold-silver ores although base metal sulphide ores are not common in the younger set, which has been mainly valuable for precious metals. Uraninite has been found in both types further substantiating Knopf's statement that many of the older deposits were reopened with the addition of cryptocrystalline quartz of the second period of mineralization so that composite orebodies were produced. The older deposits will be referred to as the base metal type and the younger as the siliceous reef type.

Uranium-Bearing Deposits

Siliceous reefs: One of the most striking structural features of the northeastern part of the batholith is the presence of bold outcrops resembling vertical dikes which form the crests of ridges and persist for as much as 5 miles. They are composed essentially of cryptocrystalline quartz and have been repeatedly brecciated and then recemented by quartz of varying colors ranging from white to black through various shades of brown to red. Mineralogically, the reefs are of simple composition with only pyrite—much of it very fine-grained—as a common sulphide mineral. Small amounts of chalcopyrite and molybdenite, and an occasional spot of galena and ruby silver, are the only minerals that have been



This general geologic map of the Boulder batholith region of Montana is after the Geologic Map of Montana, *Andrews et al*, 1944. Batholith occupies a strip of mountainous country about 18 miles wide between Butte and Helena.

positively identified in addition to the uranium minerals. The red hematitic coloration of gangue and wall rock minerals characteristic of many pre-Cambrian uranium veins is not conspicuous in these deposits. Anomalous radioactivity is found at frequent intervals along the outcrops and at one locality pitchblende-bearing ore has been mined almost from the grass roots. At least a scattering of secondary uranium minerals, principally the phosphates—autunite and meta-torbernite—are generally found associated with radioactive anomalies. In the richer grade material gummite associated with remnants of pitchblende is not uncommon. A research project, sponsored by the AEC and directed by Harold Wright of Pennsylvania State University, has as one of its main objectives a study of the nature and distribution of the secondary uranium minerals to learn more about the extent of movement of uranium by ground-water action and its possible effect on ore concentrations.

Present knowledge indicates that uranium in the reefs is principally present in pods measuring tens of feet along both strike and dip and thus presents relatively small targets for exploration. However, the gross value of one such orebody, now largely depleted, is such that a moderate expenditure is warranted to find similar concentrations. Diamond drilling has been partially successful in extending surface showings to depth but geophysical and geochemical methods may prove to be as effective, and more economical, for the long strike lengths not yet explored. A radiometric grid pattern of the surface followed by a few short diamond drill holes has served in one instance to outline a small low grade deposit that could be the start of a new mine. Such deposits are not confined to the northeastern part of the batholith but are also present to the west and south of Butte. Preliminary exploratory drilling on one of these, below a small surface showing of secondary minerals, has disclosed pitchblende associated with stibnite, an assemblage unobserved elsewhere in the batholith. Other such opportunities exist in the region and continued exploration, with initial assistance by the Government where warranted, may result in a worthwhile contribution to our uranium reserves from this type of deposit.

Base Metal Veins

Small amounts of uranium are associated with base metal deposits in many parts of the batholith, including the famous Butte district. For the most part observations have been limited to radioactive material found on the dumps of long-abandoned mines. Unfortunately, uranium was never recognized as a constituent of the ores during mining operations and there is no record of how it occurred with respect to the other metals. An attempt is being made by a private company, with some assistance from the AEC, to reopen the Gray Eagle mine, one of the old, more accessible mines, that has a small tonnage of shipping-grade uranium ore on the dump. A significant feature is that this mine, located north of Basin, lies in perhaps the most prominent vein system (Comet-Gray Eagle) in the entire batholith. The mineralized shear zone ranges up to 200 ft wide and extends at least 5 miles in length with radioactive material on many of the dumps from the deeper exploratory workings. Little radioactivity can be detected at the outcrop.

First carload of uranium ore from a base metal vein was shipped last fall from the Lone Eagle mine situated about 10 miles west of Clancy. The uranium was apparently a late addition to these veins and occupies sections that have been extensively faulted and fractured. It is present primarily in the form of pitchblende and occurs as thin seams and coatings on fracture surfaces. Intimately associated with chalcedonic quartz—usually dark gray to black—it occurs with vein material that is not of ore grade in its base metal content. Radioactive material on the dumps usually is slightly oxidized, with the formation of small amounts of secondary minerals. It is hoped that within the next year or so enough exploration can be accomplished to determine whether or not significant quantities of uranium can be mined profitably from deposits such as these.

Occurrence of uranium in the Butte district is of little more than academic interest at present in indicating that the entire batholith may be considered a uranium province. Uranium-bearing vein material occurs in a number of widely scattered spots particularly in the intermediate and peripheral zones of the district. Reddish colored siliceous vein matter with abundant pyrite characterizes part of the radioactive material while some appears to be associated with iron and manganese oxides in an unidentified form. Pitchblende has been identified from the former. An attempt was made to delimit favorable areas for underground examination by checking the exhaust air shafts for radioactive dust, a technique successfully employed in the Rhodesian copper belt, but dilution rendered this method ineffectual.

Outlook for Jamaica: Mining Upswing

by H. S. Strouth

JAMAICA—bauxite and gypsum—but what else? Does the Caribbean island have anything more to offer in the form of mineral wealth? One answer may be iron ore deposits which show enough promise to warrant exploitation in the near future by a company associated with Standard Ore & Alloys Corp.

In addition, Jamaica is reported to have gold, silver, platinum, copper, lead, zinc, manganese, cobalt, and a great many nonmetallic minerals. Of these, only platinum has not been produced commercially in the past. Right now, Jamaican bauxite is getting most of the publicity, but not too long ago other mining operations were in progress. Lack of proper interest, insufficient roads, and scarcity of venture capital forced those mining properties to suspend production.

But with the advent of operations by Kaiser Aluminum Co.; Jamaica Bauxites Ltd., subsidiary of Aluminum Co. of Canada; and Reynolds Jamaica Mines, subsidiary of Reynolds Metals Co., interest in other minerals has revived.

History

The Spanish who landed in 1494 left signs that they realized the mineral potential of the island. They named certain places Rio Cobre, or Copper River, and even shipped copper in 1598. The next roadsign in Jamaican mining history occurs in 1836 when Mount Vernon Copper Co. and the Wheal Jamaica Copper Co. mined ore on the islands. In 1854 some of the copper was shipped to Revere Copper in Boston.

Foundations of the crushing mill and concentration plant of the Hope mine, owned by the Duke of Buckingham in the 1850's, still remain. It is known that the mine contained lead and zinc, but the paucity of historical remains makes it impossible to determine the extent the mine operated.

In more recent times, a group of mines, mainly producing copper, were brought together by the Jamaica Consolidated Copper Co. between 1906 and 1909. The mines were the Congo Hill, Victoria, Sylvia, Iva, and Elma, with estimated ore reserves of 1½ million tons.

Possibility of future mining development is borne out by Jamaica's geological formation. It is believed that the greater portion of the island's geological structure dates back to the Cretaceous or Tertiary period. Structures were highly metamorphosed by the intense igneous activity of that era. Principal metallic mineral deposits and hydrothermal veins are in the interior mountain ranges, particularly the Blue Mountain series.

Working with rather limited means, the local Geological Survey has done an excellent job of surveying parts of the island and has been of tremendous assistance to both local and U. S. interests.

Government and People

The island is about 4700 sq miles in area and contains 1.5 million people. Approximately 200,000 persons live in Kingston, capital and major port.

Aside from bauxite production, this gypsum operation represents principal type of mining endeavor in Jamaica, but iron ore and other minerals seem to be in the future picture.

Mountain ranges rise to more than 5000 ft and only a few roads, to resort towns on the north side of the island, are good. Most of the roads are narrow gravel affairs that wind perilously through the mountains. Places where vehicles going in opposite directions can safely pass are rare. Aside from Kingston, there are no major cities in Jamaica. Spanish Town, Mandeville, and a few others can be termed small towns.

The island is a Crown Colony with a status approaching that of a Commonwealth. It has its own parliamentary system with almost all political groups adhering to labor party politics. Most of the voters are laborers. Thus, the party in power, led by the incumbent First Minister, Juan Bustamente, differs little from the Peoples National Party, major opposition group. Both are strongly anti-Communist. Jamaica's population is about 95 pct nonwhite and gradually people of African and East Indian extraction are taking over the majority of Government positions. These political leaders appear to be well qualified and have excellent educational backgrounds, with many of them enjoying spectacular careers before entering Government. Incidentally, the old, established law firms continue to enjoy their strong influence on politics. Cooperation between these firms and Government officials appears to work well. However, the number of people who are in Government, politics, and major industry is relatively small. Thus, the custom of settling differences over pink gins at the Cricket Club, Myrtle Bank Hotel, and other favorite spots fits in nicely.

There are several extragovernmental agencies, one of which is the Industrial Development Corp., active in developing natural resources and industry on the island. Right now, in addition to metals companies, there are a few U. S. firms in construction and trade. They are reported doing well.

The Industrial Development Corp., headed by Robert Lightbourne, is investigating and furthering, in a semigovernmental capacity, the possibility of developing fertilizer, alfalfa dehydrators, better road systems, the pigment industry from high iron bauxite residues, and development of minerals.

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Labor is plentiful and fairly easy to train with wages ranging from one shilling per hr to about £7 per week. Owners and union officials usually settle local difficulties on a friendly basis.

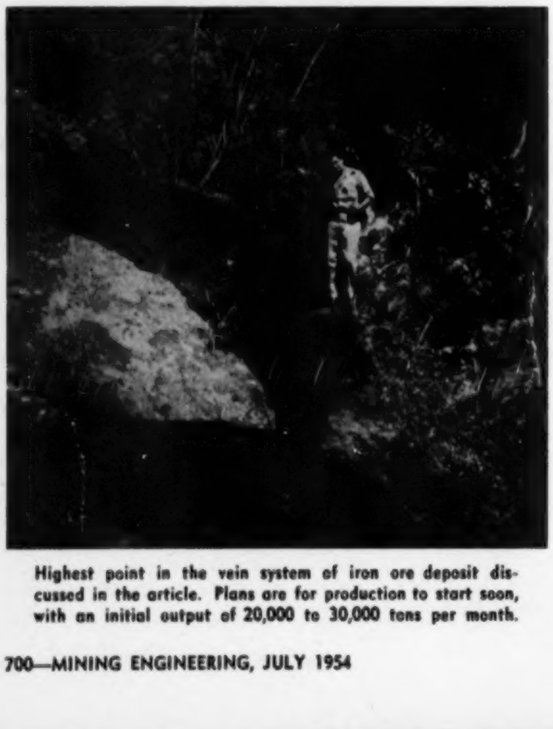
Excellent loading facilities belonging to gypsum producers and naval and coal installations are located near Kingston. Enough available space exists to permit additional loading installations at the deep water front. Main gypsum producers are Bellrock Caribbean Ltd. and Jamaica Gypsum Ltd.

Iron Ore

The iron ore deposits which are controlled by the company associated with Standard Ore & Alloys Corp. are in the Blue Mountain Range about 25 miles south of Kingston at an elevation of 2000 to 3000 ft. Within the limited concessions granted, hematite and magnetite orebodies low in phosphorus, silica, sulphur, and averaging 64 pct Fe have been outlined. They could yield about 20,000 to 30,000 tons per month of ore needing no further treatment. Ore can be quarried. While roads existing near the orebody could be utilized to bring in equipment and bring out 5000 to 10,000 tons monthly, an additional short-cut would be needed to carry production of 20,000 to 30,000 tons and cut transportation costs. Mining and transportation costs are comparable to those in other parts of the world and the locale should make the ore attractive to the U. S. market.

Ore in depth is pyritic, similar to some California deposits near Kelso. However, there is a large body of uncontaminated ore above this level. Presence of pyrite in other locations on the property might signify that copper and other minerals may be present at lower depths and eventually mined successfully.

Exploration work has been done with the aid of a local mining company which did a tremendous amount of surface trenching and with the aid of certain governmental agencies flew a magnetometer survey. The survey was followed with on-the-spot inspection, mapping of the deposits, and sampling of all trenches across the vein. No drilling was necessary because of the exposed position of the deposit which is along an almost 60° incline. A mineable



Highest point in the vein system of iron ore deposit discussed in the article. Plans are for production to start soon, with an initial output of 20,000 to 30,000 tons per month.

Loading facilities at Bellrock Harbor are cast against the background of the Blue Mountains of Jamaica. Port facilities can be expanded to take care of additional traffic.

orebody in excess of more than 1 million tons was established by calculating the exposed portions of the ore only and discounting any ore below the 150-ft level, which was found to be contaminated by sulphides. There is a possibility that the ore reserves will be considerably larger within the total claimed area because of additional deposits recently located.

A trial shipment of between 10,000 to 20,000 tons should be produced within the next six months. If operations appear satisfactory, a monthly production of 20,000 to 30,000 tons of high grade ore is planned. U. S. personnel will be kept to a minimum, with local labor employed in most cases. The engineer in charge and others required near the deposit will probably live with nearby plantation owners. Deep water harbor facilities, available to the operation, are capable of loading 200 to 500 tph by conveyor.

Alluvial Sands

Alluvial sand deposits containing magnetite concentrations as high as 80 pct occur on the south coast of the island. While high titanium content of the sands makes them uninteresting for the time being, they may signify high grade iron ore in other parts of the island. Magnetometer surveys also reveal large orebodies on the island's south side, controlled by the same group. While these deposits eventually may mean substantial new ore reserves, they are now inaccessible. A lot more development work remains to be done and till then, the economic feasibility of working these deposits will remain unknown.

Until now, bauxite and gypsum have been the mainstay of Jamaican mining. Iron ore may soon be added to the list. Efforts by major companies may also revive the lead, zinc, and copper industries. Work could lead to the discovery of the origin of some high grade manganese boulders. In time asbestos, lignite, and some of the phosphates found to a limited extent may be mined.

There are a great number of radioactive mineral springs that might be worthwhile investigating. Right now, the Government reserves the right to withhold prospecting licenses from all radioactive occurrences.

Longwall Mining and Mechanization

—— With Special Reference to Nova Scotia

by Frank Doxey

AT Dominion Steel & Coal Corp. it has long been recognized that continued mechanization of mine operations is necessary in the Pictou, Cumberland, and Sidney coal fields of Nova Scotia. The varied physical conditions in these fields call for special consideration of individual cases before planning is finalized. Because standard equipment cannot be procured which would operate successfully, many experiments have been necessary over the years to keep pace with the progress made in other countries.

There are two mines, producing 2000 tpd, located in the Pictou coal field. The field is badly distorted and crossed by many faults. Seams are highly inclined and irregular and vary in thickness from 5 to 40 ft. Entries are difficult to maintain because of squeezing of the coal ribs and movement of the roof and pavement.

Output from the three operating mines in the Cumberland field is 3000 tpd. The field is highly inclined, inclination varying from 12° to 32°. Overlying beds consist of shales and massive sandstone lenses of extreme toughness and are responsible for bumps when the stresses are relieved by extraction. At greatest depth these are among the deepest coal workings in the world. Depth of cover ranges from 2300 to 4000 ft. This prohibits room-and-pillar working and necessitates longwall operation. Working of contiguous seams concurrently to maintain output increases the already difficult conditions.

The Sydney field, with a frontage of about 30 miles, is the most important of the Nova Scotia coal fields. With the exception of one small area it is now wholly submarine. Output is approximately 21,000 tpd. Seams are 2½ to 8 ft thick, and cover in the areas varies from 600 to 2300 ft, with an average of 1500 ft from sea bottom to the top of the seam.

The seams dip in a seaward direction, pitches ranging from 6° to 40°. The shoreline is the last place of entry to the seams and distance from the bank to the working faces is generally over 3½ miles, in some cases as much as 6½ miles. Ventilation is a problem and requires the construction of large permanent airways.

Getting and Loading Coal: In 1925, in view of heavy pressures exerted by thickness of cover overlying the seams, roadways and pillars of the room-and-pillar system being worked began to break up and coal was lost. It was decided that a change in the method of extraction in areas with heavy cover was necessary, and experiments were made with many short walls and longwalls varying between

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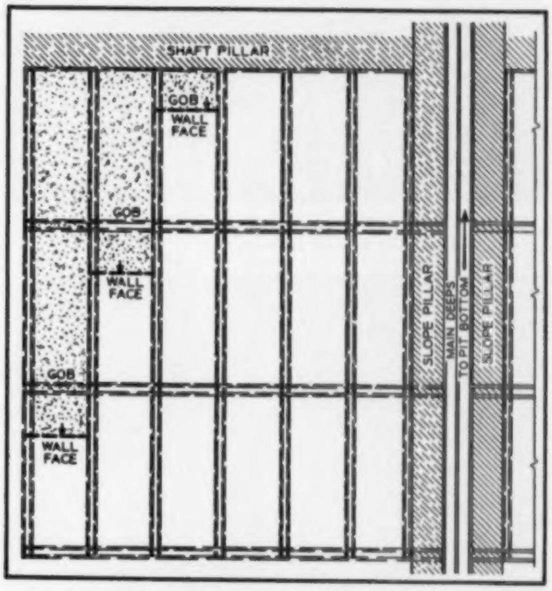

Fig. 1—An example of longwall advance retreating.

90 and 250 ft. Trial and error proved that the best operating length was between 400 and 500 ft, delivering all coal to the dip, with roadways to the face following a level course. The change-over was gradual, and the technique of roof control developed with the system, so that falls to the face are now very infrequent.

An advantage of longwall mining is that it yields 95 pct extraction, especially important in coal seams of high quality or in seams where faults or disturbances restrict the workable areas. This percentage of extraction is based on the fact that the longwall advancing system takes development faces where pitch permits instead of driving headings and leaving roadway pillars. This system yields high tonnage during development and limits loss in extraction to duff left during operations. Accompanying disadvantages, on the other hand, are the heavy construction cost of main roadways and the necessity of driving all new flank face roadways through the gob.

If the main roadways are driven through the solid, and large enough pillars are left on each side for protection against flank face weights, then the width of solid coal is approximately 1700 ft. This represents 10.6 pct of the coal available, or 89.4 pct extraction of the whole. These pillars, however, are of such size that they provide a useful pillar drawing area as a final operation of the mine. It may be that although the seam cannot be generally mined by the room-and-pillar method, it can be adapted to

The Transactions papers appearing in Mining Engineering during 1954 will subsequently appear in AIME Transactions Vol. 199 and may be permanently referenced to that volume.

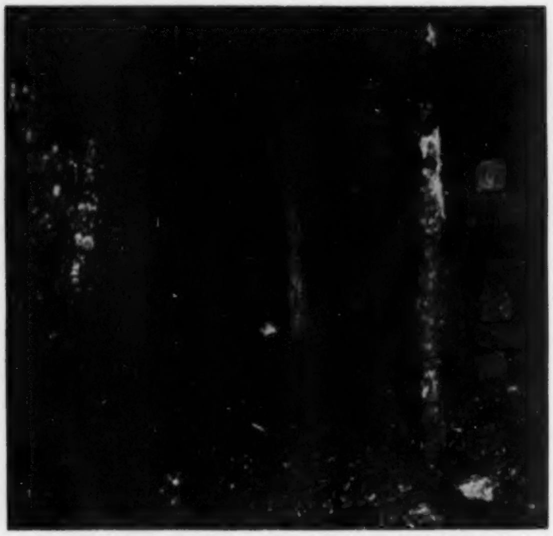

Fig. 2—Face conditions on a hand-loaded wall. Wall is off line and supports are set haphazardly.

Fig. 3—Face conditions on a mechanized wall. Wall is straight and supports are set to line.

Fig. 4—Chock release for easy withdrawal.

Fig. 5—Back brushing 250 ft from face.

the system during this final operation because of the comparatively short distances through the pillars. It is reasonable to assume that by this method 60 pct extraction of the pillars would be possible, making total extraction of the mine 95.1 pct. Should it be decided to extract pillars by the retreating longwall method, 75 pct extraction of the pillars could easily be obtained, making a total extraction of 96.6 pct. Allowing 5 pct for duff losses in working, extractions would be 90 pct and 91 pct respectively.

Advancing System: The advancing system, operated in most longwall mines, is determined by the following factors: 1—desirability of production in quantity as soon as workings are clear of shaft or slope pillars; 2—inability to hold headings in the solid, either during drivage or face extraction; 3—high initial cost of preparing a mine for retreating; 4—liability of seam to spontaneous combustion.

Most mines except Cumberland in the Nova Scotia areas practice longwall advancing. Walls are between 400 and 500 ft long and work singly or in multiples of these lengths, 2500 ft being the longest length advanced each day.

Longwall Retreating: Apart from the high initial cost, longwall retreating appears to have advantages over longwall advancing, provided that development headways can be driven in series and fully mechanized and that restricted output during the development period is not a serious factor. There are, however, many problems accompanying the system, such as ventilation in gassy seams, material supplies, heaving pavement, the necessity of running long conveyor belts from faces to auxiliary haulage levels, or the difficulty of holding loader ends in the pillars outside the working face. It has been found from experience in Nova Scotia that longwall retreating has no operating advantage over the advancing system, except where the physical conditions are ideal, or in some special application such as that in the Cumberland field where the workings are subject to bumps.

In this case, when longwall advancing was worked the whole of the working face was affected, sometimes very seriously, when a bump occurred. In view of this it was decided to try the retreating system; after the change it was found that when a bump took place the roadways leading to the face were the places damaged and the working face was scarcely affected. Removal of the bump area from the working face to places more remote from the workmen was a safety step which fully justified the system.

Longwall Advance-Retreating: Where development headings are easily driven and maintained, this method can be a useful compromise between the two systems, panel development being prepared

near the shaft or slope pillars. Development headings proceed to the lateral boundary or boundaries, opening up panels of faces on one or both sides, the faces being retreated to the levels and back to the main haulageway while further development is proceeding inby for replacement purposes. Where total extraction is essential, faces can be extracted as shown in Fig. 1.

Choice of Face Line: Generally speaking, the best line of face is at right angles to the cleat for machines similar to the Meco-Moore, Gloucester getter, and Dosco miner, while for machines of the German plow and Samson stripper type the line is apparently better parallel to the cleat.

In flat seams either system is reasonably easy to plan, but in steep work such as obtains in the Nova Scotia fields the line of face is usually determined by the dip rather than by the cleat, as disadvantages of working heavy machines across outweigh advantages of working with the cleat or across it.

Roof Control: The roof of the longwall workings in Nova Scotia mines is controlled by the building of chocks and packs in the gob and the setting of timber at the face.

Built of old stone and wood, the packs are 12 ft wide and in most cases are put on at 50-ft centers. The chocks, built at 7-ft centers, are 6x6-in. hardwood, 2½ ft long in the Sydney field and 4 ft in the Acadia and Cumberland fields. Chock releases are placed at convenient height for withdrawal.

Timber at the face is set at 4-ft intervals. When a large area of roof is exposed where the men are working, it is essential that as near perfect control as possible should be kept. If this is achieved the getting of the coal, of course, is made easier.

It is necessary, therefore, to maintain the fracture line of the roof behind the chocks in the gob. This can only be achieved if the chocks are well built and a high standard of chocking, packing, and timbering is maintained.

The chocks are advanced daily after the packs have been extended and the roof stone allowed to fall behind the chocks. The timbers also are drawn off in the gob. It is very important that all back timber and chocks be drawn systematically to keep the weight evenly distributed and equally important that all pack wall sides be well built and in a straight line.

This enables the roof to break off along the side walls of the packs in addition to breaking off behind

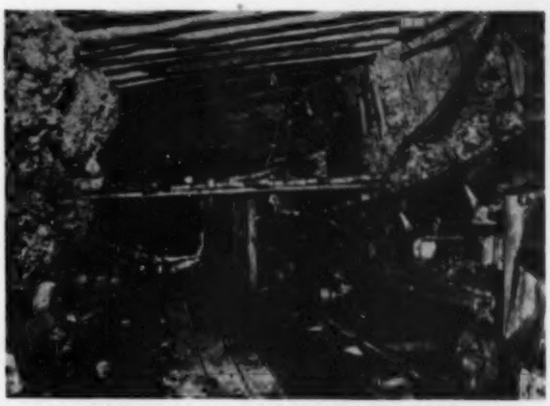

Fig. 6—View of roof-bolted back brushing 250 ft from face. Side bolts and a section of the Sydney Mines gate belt loader are also shown.

the chocks, thus forming a series of corrugations at right angles to the face which give support to the upper measures.

When the system of packing for any longwall section has been determined, packing plans should be made and marked up weekly, showing pack positions and advance, and any other condition which has occurred during the week, such as falls to face. These plans compile a history which can be very useful in assessing the reason for any given face condition at any time.

The position of the chocks in the waste, with the resultant fracture line, determines to a very great degree the actual roof condition at the face and the load and position of the roof over the coal being worked. This is very important where mechanized mining is practiced and where roof stresses are released rapidly. Figs. 2 and 3 show clearly the effect of roof control on face conditions.

Many systems of timbering, packing, and chocking have been or are being practiced in longwall mines. Some of these are outlined as follows: 1—packing and chocking, with wooden face supports. 2—packing and chocking, with steel face supports. 3—chocking and steel face supports where the caving system is used.

These systems are practiced in varying forms in Europe and Britain, No. 3 being the least used. All have been tried in Nova Scotia mines.

Fig. 7—Side breaking away over roadside packs.

Fig. 8—Roadside after side-bolting with 8-ft bolts.

Fig. 9—Roof bolting in roadway 800 ft from working face. This is not a substitute for packing and chocking on roadsides.

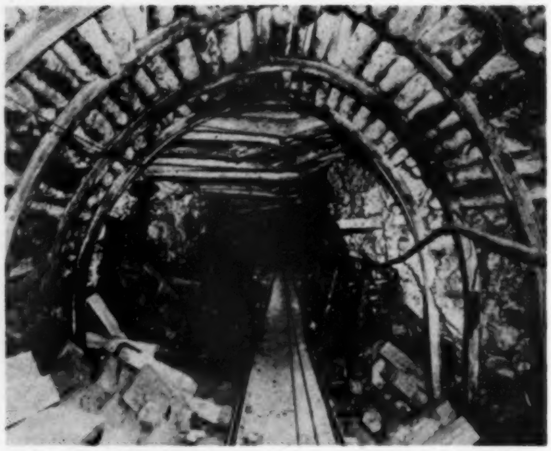

Fig. 10—A roadway where bolts have not been used, 800 ft from the working face.

Rigid and yielding props play a very important part in roof control, and many fine examples are in existence. The hydraulic prop has become very popular in Britain, and many hundreds of thousands of rigid and mechanical yielding props are in use in that country. With the hydraulic prop, initial installation cost is very high, maintenance is of vital importance for efficiency, and any losses in withdrawal are very costly. In spite of this, however, reduced cost per ton can be achieved over a period of time, provided losses are kept to a minimum.

It must be borne in mind that with thick seams the question of handling heavy steel props must be considered, as well as safety of the props in steeply pitching seams. System No. 1, that is, packing, chocking, and wooden timbering, is the one now used in Nova Scotia, owing to seam thickness and pitch, hard and slippery pavement, and face falls when the caving system was tried. Over the years the system has worked reasonably well and has improved considerably since the introduction of chock releases, Fig. 4.

At one period roof bolting on longwall was tried; this was not satisfactory as a substitute for conventional support, but short bolts offered distinct advantages where soft shale overlying the seam had a tendency to fall with the coal. Roof bolting is also desirable across roadheads where moving conveyor equipment to new positions requires the removal of props. No matter what system of face and gob support is used, it must have the effect of creating a fulcrum behind the working area on the face and so relieve the pressure as to eliminate roof breaks at the coal face.

Pneumatic Stowing: Pneumatic stowing of longwall workings has been practiced for several years in Europe and Britain. It has been used with particular success in the Doncaster and South Wales coal fields in Britain, in the Doncaster field as a spontaneous heating deterrent and in South Wales as a means of extracting a seam full of breaks which was sandwiched between a roof and pavement full of breaks caused by working of contiguous seams.

In the Doncaster field, where the Barnsley seam is highly spontaneous, strip packing and roadway packing is done by pneumatic means. At Bullcroft colliery a completely self-contained system is in operation. Mine waste is loaded into cars and taken to an underground crushing plant. After crushing it is returned in cars to the stowing machines located in the face roadways, tippled, and stored. The waste used is $-2\frac{1}{2}$ in. This system, while expensive to establish, has reduced the incidence of spontaneous heating, decreased the number of men in the packing team on face, dispensed with a large crew of men whose sole duty was to deal with heating, and provided continuity of output.

At the other collieries in the district, and also at the South Wales mines, waste is provided for stowing from the surface spoil heaps.

Roof Control in Roadways: As mentioned previously, the future condition of roadways is chiefly determined by roof control at face. When the roof is exposed it should be supported immediately and packs put on as soon as possible to control subsidence and prevent bed separation. The rib should be protected by a pack to take care of any cutoff along this side. This is eminently desirable for all roadways but is to be emphasized for steep measures. To prevent side pressure and ease roadway maintenance the amount of brushing taken down at the face should be kept to an absolute minimum consistent with the area required for ventilation and transportation.

Roadside packs should be well built and solid throughout to give maximum support to the roadway, break off the wastes on each side, and prevent leakage of air through the gob. This last factor is particularly important in seams liable to spontaneous combustion.

The roadway between the first back brushing and the face end should be given maximum support that is reasonably easy to withdraw. This can be done in many ways, for example: 1—straight wooden booms pocketed in the side of the roadway and middle set where necessary; 2—straight or cambered steel I-beams pocketed in the side; 3—wood or steel herring-bone supports; 4—steel arch girders set on stilts or loose rock, soft wood, and wire bags filled with waste.

Back brushing supports are of a more permanent nature and may take the form of steel arches; straight or cambered girders, propped or pocketed in the side; steel and wood *moll* supports; or roof bolting. Wood and stone packs on roadsides, straight wood booms supporting first brushing, and steel arches or roof bolting at first back brushing are the methods generally used in Nova Scotia. Roadside

packs also have an important part in roof control at the face and maintenance of a good roadway behind.

Generally speaking, the first back brushing in gob roads is about 250 ft from face where the seam is 5 to 6 ft thick and could be a longer or shorter distance as the seam thins or thickens, Fig. 5. Where a number of faces are advanced together, care should be taken to keep them as nearly in line as possible. Should steps develop between faces, the roadway will be subject to the weight of the leading face and will be further disturbed by the trailing face, instead of being allowed to settle uniformly. This condition invariably produces bad roadways.

In seams 5 to 6 ft thick it is usually necessary to take one or more further back brushings, particularly in roadways in the center of a multi-wall section in comparatively flat seams and in the center and to the dip of the center roadway in steep measures.

Roadway Roof Bolting: Where proper roof control is exercised, so that breaking off takes place in the gobs alongside the roadway and the roof spanning the roadway is left unbroken, roof bolting at the back brushings can be used to distinct advantage, Fig. 6. The effect of subsidence is not felt nearly so badly in a roadway supported in this manner as it is in a conventional steel arched roadway. Spare roads or bypasses are much more readily maintained and traveling between cars much easier. Bolts must be long enough to maintain a compact body. Eight-foot bolts are used in the Nova Scotia applications.

It is common for the sides of longwall roadways to break away back over the packs for a distance of 3 to 5 ft, Fig. 7. This condition can be prevented by the insertion of side bolts, Fig. 8, a comparatively new system of support for longwall roadways that shows great promise.

When it is considered that four bolts and a wooden boom replace one arch and lagging, it will be seen that the saving in material cost is tremendous. Cost of roof-bolted sections is 33 pct cost of arching.

Great care must be exercised in choice of roadways for roof bolting, Figs. 9 and 10, and it must be emphasized that roof bolting cannot act as a substitute for good packing and chocking on road sides.

Fig. 11—Discharge end of the Sydney Mines loader.

In gassy seams pillars left between one face or set of faces and the next prevent gobs from settling evenly and cause roof breaks which may convey methane from any bed separation or from nearby overlying seams into the adjacent roadway. If pillars must be left in a gassy seam to prevent fire or flooding or to provide roadway support, methane drainage is desirable, depending on the quantity to be piped to surface or into the return a safe distance from the face. In Nova Scotia mines there are two such installations for piping gas into the returns. The installations are new and sufficient detailed information regarding drainage is not yet available, but evidence is that the system will be invaluable.

Roadway and Face Transportation

When longwall mining was first introduced in Nova Scotia, coal-cutting machines were used to undercut the coal, which was then drilled and brought down by explosives to be handfilled onto shaker conveyors.

At first the coal was loaded from the shaker conveyors directly into mine cars. This system worked reasonably well where the faces were short but fell far below the speed and efficiency necessary for longer faces and greater output. In view of this, gate belt conveyors were introduced which picked up the coal from the face conveyors and transferred it to a suitable loading point outby.

The conveyor was extended each day following a strip off the face and the loader end remained in its semi-permanent position, to be moved only when

Fig. 12—Main haulage diesel installation.

Fig. 13—Auxiliary haulage diesel installation.

conveyor length, varying from 1200 to 2000 ft, resulted in overload. Such loader ends easily handled large outputs, but in steep thick seams, where heavy maintenance is necessary, the length of the conveyor soon became a distinct handicap, hindering repair work and damaging conveyor structure. The company therefore developed a fixed length gate conveyor, Fig. 11, known as the Sydney Mines loader because of its place of origin.

The gearhead of this conveyor is especially constructed to transfer the coal at right angles to side load into mine cars. Because the side-loading chain conveyor is clutch-driven from the main belt conveyor gearing, cars can be uniformly loaded and spillage during spotting is prevented, the bin being of sufficient capacity to hold the coal while cars are being changed. A further clutch-driven rope drum is used for self-hauling the conveyor, which is on wheels and track-mounted, in or out as required.

A tail end auxiliary scraper chain conveyor is driven through sprocket and chain by the tail drum of the belt conveyor, placing coal on the belt conveyor in the direction of travel. This reduces belt wear and also keeps the receiving end of the gate conveyor at a very low level, which in turn assists materially both in the discharge of coal from the face to the gate conveyor and in the loading of coal from the *Dosco* miner onto the face conveyor.

This fixed-length conveyor, usually 300 ft, moves ahead each strip off the face; the back brushing, being just ahead of the loader end, must be done each shift to allow the conveyor to move in. This accomplishes the back brushing and systematically maintains the same distance between back brushing and face. Further, the load end operator works under permanently supported roadway with plenty of room for handling mine cars. Where the conventional gate belt system is used a rigid schedule of back brushing and repairs should be maintained.

Auxiliary Haulage: In the early days horses were used for hauling cars along loading levels, later being replaced by endless or main and tail haulage. During the last four years Diesel locomotives have been introduced into the Nova Scotia mines to haul between the loader ends and the main deep landings and have proved immeasurably superior to the rope systems previously used.

Introduction of the diesel locomotive has brought in its train more meticulous tracklaying, fewer derailments, and fewer haulage accidents. In longwall working, where the roads run through the gob,

Table I. Comparative Statistics for Diesel and Rope Haulage

Diesel Haulage			Rope Haulage		
Accidents	Days Lost	Tons Per Accident	Accidents	Days Lost	Tons Per Accident
2	28	135,974	8	468	28,289

diesels are infinitely safer than electric trolley wire locomotives and far more flexible. Objections are sometimes raised about the safety of this type of transport, but from experience it has been found that the safety of the diesel locomotive leaves nothing to question if good roads, good track, good maintenance, and good ventilation are insisted upon by operators and inspectors.

Table I, above, shows typical diesel and rope installation accident statistics in the same mine in Nova Scotia. Figs. 12 and 13 illustrate two diesel installations.

Because of the reduced number of roadways in the longwall system of mining, special care should be taken that plans provide for main roadway sizes adequate to carry all ventilation necessary for the life of the mine, cutting down air pressure loss between pit bottom and working face to a minimum. High water gages should be avoided wherever possible, particularly in seams liable to spontaneous heating. There should be enough face splits to provide adequate quantities of air with low velocity.

In pitching seams, however, where ascensional ventilation is necessary, some compromise may be necessary on these points. Where mechanical mining is taking place, low velocities should be aimed at to assist in dust suppression measures. Degassing is a move in this direction also.

The room-and-pillar system in comparatively flat seams with good physical conditions is easy to mechanize, but the longwall system does not lend itself so readily, particularly in steep work. Over the past few years this matter has been given careful consideration in longwall countries and various machines have been devised and manufactured.

The coal plow which met with reasonable success in the soft, uncleated coals in Germany was not so successful in the harder cleated bituminous coals in Britain. Of all the British and European machines, the British-manufactured Meco-Moore longwall cutter loader apparently has been the most successful in British mines but has been adaptable only in certain conditions and in the flatter seams. The coals of Nova Scotia, while classed as soft coals, are very similar to those of Great Britain, being fairly hard with well-defined cleavage.

The steeper gradients of the seams, however, posed a problem which required special consideration, since no suitable machines were available. In view of this, Dominion Steel & Coal Corp. engineers designed the machine known as the Dosco miner, based on the Joy Manufacturing Co. principle of passing a number of cutting chains in a shearing action through the coal face.

In 1949 a prototype machine was manufactured by Trenton Industries Ltd., a subsidiary of Dominion Steel & Coal Corp., and put to work in an open strip mine to test its qualities. After getting and loading some 20,000 tons of coal the machine was completely redesigned and the present machine shown in Figs. 14, 15, and 16 was evolved. Eleven such machines are now working and giving very reasonable results, the best daily output to date from one machine being 587 tons in an 8-hr shift and the best weekly output 2860 tons in five shifts.

The machine consists of a main body split in two parts, one part sliding on the other. The whole is mounted on a main frame and caterpillar-propelled. The cutting head is made up of seven cutting chains of the Austin Hoy ball-joint type which carry 536 carboloy-tipped cutting bits.

The machine receives its power through two trailing cables extending from the magnetic switch gear situated in the loader gate to a switch on the machine. The cables, No. 2/0 and No. 6 B & S, are identical in construction apart from the power wire size, both having six wires: three individually screened power wires, two pilot wires, and one ground wire. Trailing cables are 75 ft long to facilitate handling. The pilot wires in the cable form part of an intrinsically safe operating circuit. The operator, by

Fig. 14—A view of the Dosco miner, designed by engineers of the Dominion Steel & Coal Corp.

Fig. 15—The Dosco miner cutting head sumped 18 in. into coal. Note water spray for dust suppression.

Fig. 16—The Dosco miner cutting head at top of lift. Eleven of these machines are now in use.

Fig. 17—Magnetic switches for use with Dosco miner are operated by snap action switches on the miner.

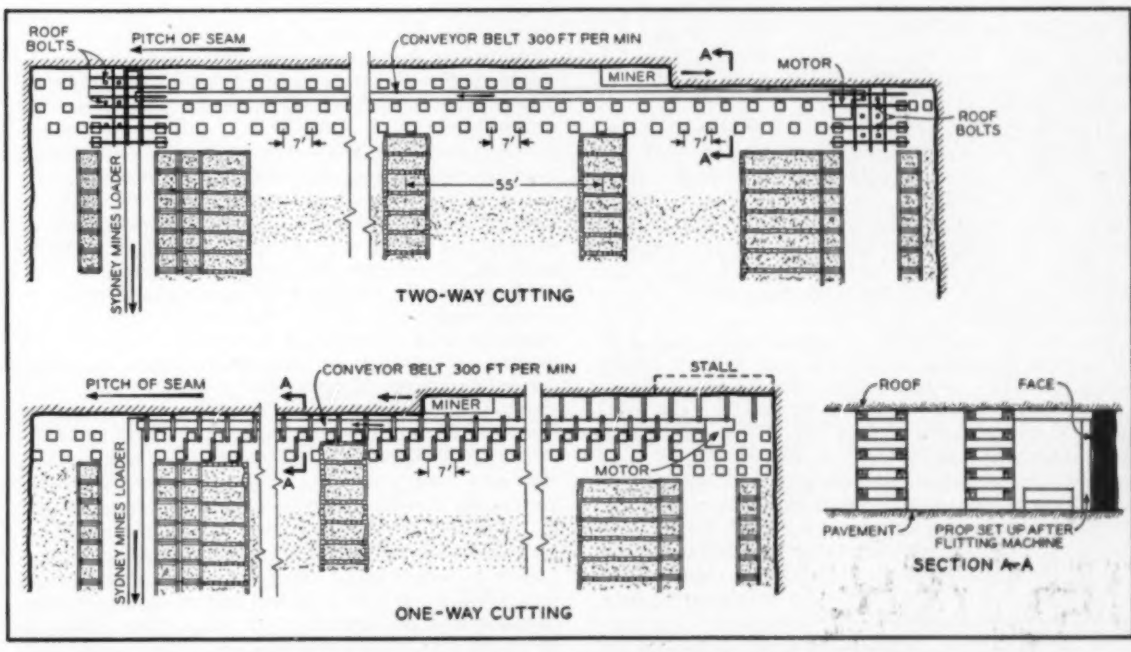

Fig. 18—The one-way and two-way systems of the Dosco miner longwall operation.

closing or opening snap action switches, makes or breaks the pilot circuits which control operation of the switches outby the loader end, see Fig. 17.

The cutting chains carry the coal back to a built-in variable-speed (0 to 500 fpm) hydraulically driven conveyor in the machine, which in turn discharges it to the face conveyor.

The 2/0 cable supplies the power to two 75-hp water-cooled motors, each coupled through cone worm gear cases to the main driving shaft in the cutting head. The No. 6 cable supplies the power to a 30-hp water-cooled motor for the driving of three hydraulic pumps. Two 24-gal pumps supply power to the sumping cylinders, jib-lifting cylinders, rear jacks, and caterpillar crawlers, and one 11-gal pump supplies power to the cross conveyor. After passing through the motors the water is atomized through sprays to control dust made during cutting.

The 75-ft lengths of cable attached to the machine are changed over to fresh couplings as the machine proceeds along the face. Seventy-five feet of cutting with an average of a little over 1 ton per ft yields approximately 80 tons of coal. The size of trip servicing the loading end is therefore made to fit within this tonnage limit, so that cables are changed over while trips are being changed, thereby avoiding loss of time during cable changing. The cutting cycle of operation is as follows:

1—Move whole of machine to the face on caterpillars with cutting head in down position.

2—Sump cutting head into coal a distance of 18 in. This is done hydraulically, the cutting head and conveyor sliding forward on guides. Telescopic splined shafts allow continuous drive while this is taking place.

3—Lift cutting head through the coal to top of seam, or to predetermined height.

4—Retract cutting head.

5—Lower cutting head to pavement.

6—Move ahead on caterpillars and repeat.

The whole cycle takes 25 to 30 sec to complete, so that cutting speeds up to 3 fpm are easily obtained. In a 6-ft seam this means a production of about 4 tons per min, but since less than half the time for the cycle is productive the rate of production is 8 to 10 tons per min.

The shaker face conveyor, which was adapted to the machine, was completely unsatisfactory and had to be replaced by a 30-in. belt conveyor with a running speed of 350 fpm.

Too much stress cannot be placed on the importance of attention to detail in setting up the belt conveyor, which should be built to a line each time it is moved. It should be level across and as free from undulations as practicable.

Two systems of loading are in operation, one-way and two-way loading. In the one-way system, which is used in the steeper mines, the machine starts cutting from a stable at the top of the face, the timberers systematically setting supports to the mine regulations. In this system one end of the boom is hitched into the face, the gob side end being supported by a prop 5 ft from face. This allows for flitting back the machine to the top of the wall at completion of the cut. The stable in this case is cut by machine, drilled and loaded by three men. It is 30 ft long so the machine can be maneuvered into its new position. In the two-way system the machine cuts its own stable. The support method in these systems is shown in Fig. 18.

The face conveyor is driven from the tail end, that is, from the top end of the face, to allow the belt to be kept near the pavement throughout the whole length of the face and to facilitate loading at the mine loader receiving end. The nine-man machine crew for the one-way system includes 2 operators, 3 timbermen, 3 stablemen, and 1 official. The six-man crew for the two-way system consists of 2 operators, 3 timbermen, and 1 official. These crews replace 50 men: 40 loaders, 2 cutters, 4 drillers, and 4 shotfirers.

It will be seen that on the mechanized faces there is a substantial saving in loading manpower. Table II shows a typical crew setup in each system. These figures show the mechanized face forces to be only 57 pct of the hand-loading face forces.

Table II. Crews for Mechanized Loading and Hand-Loading System

Crewmen	Mechanized Loading	Hand Loading
Overmen	2	2
Shotfirers	2	6
Conveyor operators	2	1
Electricians	1	
Timberers	3	
Operators	4	
Maintenance men	1	
Pipemen	2	1
Belt mechanic	1	2
Material men	3	4
Panmovers	10	13
Chock drawers and packers	18	18
Stall	3	
Brushers	3	3
Cutters		2
Helpers		4
Loaders		40
Total	55	96

Shifts are unproductive chiefly in the brushing, packing and chocking, and moving conveyor categories, and it is here that the next steps must be made to reduce force. One man in each roadway could be saved at the front brushing by the use of mechanical equipment for dirt disposal. The number of packers and chockers may be further reduced by the development of mechanical or pneumatic machinery for pack-building and use of mechanically or hydraulically operated chocks and props.

As mentioned previously, the shaker conveyor could not deal with the loads from the Dosco miner and was replaced by a belt conveyor. The labor required in both cases is heavy and a much more flexible and easily removable conveyor is desirable. The German panzer armored chain conveyor is becoming more and more popular in longwall workings in Britain and many revised versions are being manufactured by British mining machinery companies to meet the prevailing conditions.

These developments are being carefully watched, for it is with the conveyor of robust construction and adequate capacity that can be moved bodily by hydraulic, pneumatic, or mechanical means that further reductions can be made in oncost labor. One manufacturer has promised to attempt to develop a conveyor of this type, of capacity sufficient for the Dosco miner operation. It seems feasible, therefore, that cost results usually associated with the room-and-pillar system may be obtained in deep mining by longwall methods where the room-and-pillar system is not practicable, provided that every operation is as fully mechanized as possible. Mechanization of the ancillary operations requires further thought and development, and it is the policy to continue with experiments to bring this mechanization about.

Rock Bolting in Metal Mines of the Northwest

by Lloyd Pollish and Robert N. Breckenridge

SUCCESS in any underground mining operation is determined by accessibility of the orebody, which in turn is dependent upon maintenance of passageways to the mining zones and temporary support of the voids caused by extraction of ore. This is accomplished by one or a combination of the following methods: timbering, back-filling, pillaring, or, more recently, rock bolting.

Timbering has usually been the principal means of maintaining these underground openings necessary for mining operations. Timber, however, does not prevent ground movement beyond the scope of localized sloughing, which is indicated by the gradual failing of the timber itself. Besides this, timbering has always been a costly process, and with the decline of available supplies of timber close to the mining areas, mining men have constantly sought other methods of controlling ground.

Rock bolting is now replacing timbering at an ever increasing rate. Experience has proved that this form of ground support is just as applicable to blocky igneous rock as to stratified rock. Besides preventing sloughing of the walls and back of underground openings, Fig. 1, rock bolting has a stabilizing effect on the surrounding ground in much the same manner that steel reinforcing rods add to the strength of concrete structures. Further, rock bolting is flexible and may be applied to any shaped excavation, whereas timber sets are in a fixed pattern and the ground must often be changed to conform with this pattern.

Rock-bolting installations were made in metal mines of the Northwest as early as 1939. An exhaust air crosscut was driven that year in one of the Butte mines of the Anaconda Copper Mining Co. The crosscut was rock-bolted and gunited at the time it was driven and is still being used to exhaust hot humid air from the 3400 level of the Belmont mine. It is interesting to note that no sloughing or caving has taken place in the 14 years it has been open. Even though these early installations of rock bolts were successful, few men recognized their potentiality until recent years, when the coal mines started their programs of mechanization and the great trend toward roof bolting began.

In some areas of the Northwest stopes that previously required heavy timbering and close backfilling are now being mined by the more economical cut-and-fill and shrinkage methods. When used in conjunction with timbering, rock bolting increases the efficiency of the operation by decreasing hanging wall dilution and by making it possible to blast larger rounds.

Most of the rock bolts installed to date in mines of the Northwest have been the 1-in. diam slot and wedge type, but there has been a recent trend toward using the ¾-in. diam expansion shell bolt shown in Fig. 2. In addition to these commercially manufactured steel bolts, wooden bolts have been used with considerable success by the Day Mines of Wallace, Idaho.

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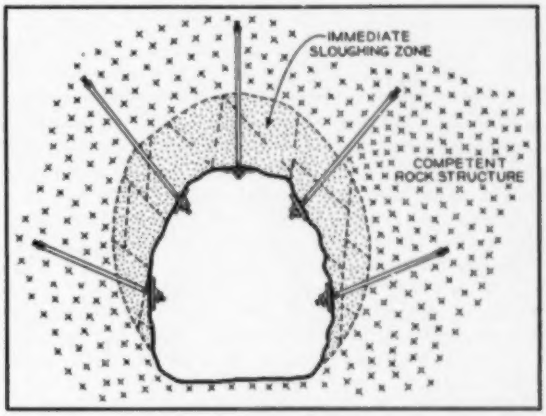

Fig. 1—Rock bolting prevents sloughing in underground openings and stabilizes the surrounding area.

Installation of the slot and wedge type requires three distinct operations, with tools for each operation: 1—drilling the hole to proper diameter and depth, 2—setting the bolt, and 3—tightening the nut. Holes are drilled and bolts set with pneumatic rock drills. A number of setting or driving tools have been used successfully, but most follow the same general pattern. Usually the driving tool is designed to accommodate a short length of drill steel on one end and the rock bolt on the other end. In this manner the hammering effect of the rock drill is transmitted through the steel and driving tool to the bolt. When machines not having stop rotation are used, slippage is allowed between the driving tool and bolt or between the drill steel and driving tool. The rock bolt nuts are tightened either with pneumatic impact wrenches or with hand wrenches. Impact wrenches are desirable because they are faster and assure adequate tightness.

Expansion shell bolts have the following advantages over slot and wedge rock bolts: 1—No special equipment other than a wrench is needed for their installation. 2—Installation is faster. 3—They are removable. 4—Holes need not be drilled to a specific depth as the expansion shell will anchor anywhere along the length of the hole. These advantages are offset somewhat by the lesser strength of the bolt, since expansion shell bolts are generally made from ¾-in. diam steel as compared to 1-in. diam steel for the slot and wedge type. One manufacturer, however, is now fabricating expansion shell rock bolts from steel of high tensile strength, which gives this ¾-in. bolt a much greater strength than that of the mild steel bolt.

Table I illustrates tests made by the Anaconda Copper Mining Co. to determine the proper hole size to use with various types of bolts and to determine

Table I. Pull Test Data on Expansion Shell and Slot and Wedge Rock Bolts

Bolt No.	Hole Diam, In.	¾-In. Expansion Shell Bolt				1-In. Slot and Wedge Bolt			
		Type A		Type B		Type C		Type D	
		Tons Pull	Result	Tons Pull	Result	Tons Pull	Result	Tons Pull	Result
1	1¼	19	Broke		Hole too small	20	Broke	21	Slipped
2	1¼	19	Slipped		Hole too small	21	Broke	22	Slipped
3	1⅜	17	Broke	14	Broke	18	Broke	15	Slipped
4	1⅜					20	Broke	17	Slipped
5	1 7/16	10	Slipped	13	Broke	15	Slipped		
6	1 7/16					18	Broke		
7	1½	5.5	Slipped	12.5	Slipped	18	Broke		

their points of failure. Bolts were anchored in the usual manner and tension was applied by means of a hydraulic roof bolt puller until failure occurred. Results show that the average failure for all ¾-in. expansion shell bolts tested occurred at 13.8 tons, and for 1-in. slot and wedge bolts at 18.6 tons.

Treated wooden bolts, employing the slot and wedge type of anchorage and constructed from straight-grained fir, have been used successfully in faulted areas and in *short ground*. Their main application seems to be in wet ground where the ability of the wood to absorb moisture causes them to expand, affording contact with the sides of the hole along the entire length of the bolt. Pull tests, made in hard dry ground, resulted in slippage of the bolt when the applied stress was only a small percentage of the calculated tensile strength of the wood.

Rock bolting increases efficiency of stoping operations. In square-set stoping it reduces hanging wall dilution, eliminates the need for heavy timber, and prevents movement of false hanging walls which cause timber to ride and break. In cut-and-fill stoping it reduces hanging wall dilution, eliminates the need for temporary safety stulls which often impede scraping operations, and makes possible the breaking of larger rounds. In shrinkage stoping it facilitates rapid mining of an orebody, increases productivity per manshift, affords a low unit cost of mining, and effects a saving in the transportation of materials.

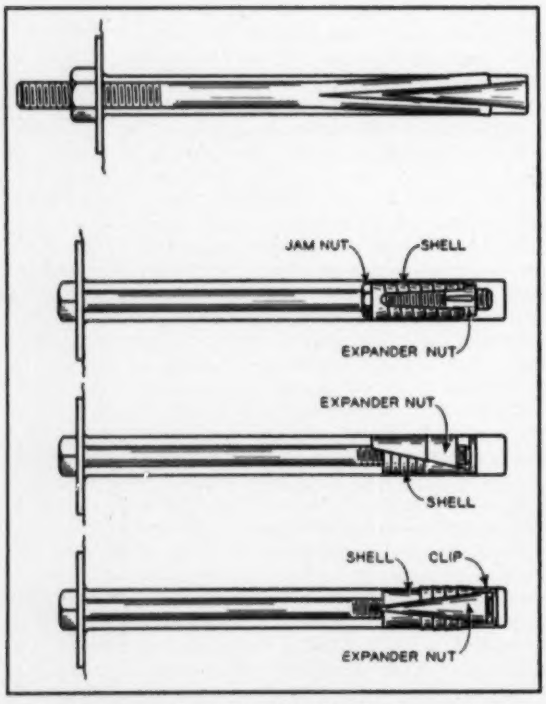

Fig. 2—An example of the slot and wedge type of bolt is shown above and three expansion shell types below.

Substitution of rock bolts for timber in development headings and haulageways reduces the required excavation by approximately 30 pct without intruding into the necessary opening, see Fig. 3. Installation of timber in waste headings requires that this extra rock be broken to accommodate timber sets, so the purpose of rock bolting is to make possible the excavation of a minimum size cross-section and secure the perimeter, or sloughing zone, by binding it to the naturally self-supporting rock structure surrounding it. Rock bolts support the ground at each point of installation, whereas support given by timber is confined to the blocking, which is normally at the junctions of the cap and posts. Further, ground may be bolted within a few feet of the breast with no adverse effects from blasting the succeeding round.

Rock bolting practices at the Butte operations of the Anaconda Copper Mining Co. and applications of rock bolting at the Sunshine Mining Co., Kellogg, Idaho, were taken as typical examples of practices in metal mines of the Northwest. The following accounts show how rock bolting has been employed effectively with various types of stoping operations as well as with almost every other type of underground excavation, see Table II.

Table II. Distribution of Rock Bolts for a Two-Year Period, Anaconda Copper Mining Co.

Place Used	Total Used, Pct	
	1953	1952
Sills	70.7	80.9
Stopes	24.8	5.9
Raises	1.7	1.7
Pockets	1.6	5.4
Shafts	0.3	3.5
Miscellaneous	0.9	2.6

The Butte mines have used 73,645 rock bolts since the start of the present program in late 1950 and are now using about 5000 bolts per month for all types of underground excavations. Both the 1-in. diam slot and wedge type and the ¾-in. diam expansion shell type are used. Standard lengths are 3, 4½, 6, and 8 ft. Although most bolts are still used for sill development work, an increasing number are being used for ground support in stopes, replacing square-set timbering. This is due in part to Anaconda's present program of mining narrow veins by the more economical horizontal breast cut and hydraulic fill method, using rock bolts for temporary support of the hanging wall and back.

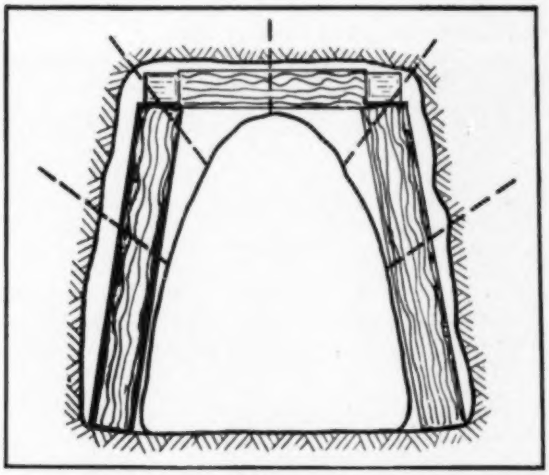

Fig. 3—A 9x7-ft rock-bolted cross-section superimposed on an 11x9-ft timbered cross-section.

Rock Bolting in Stopes: Fig. 4 illustrates the rock bolting procedure used at the Mt. Con mine in stoping by cut-and-fill method. When necessary the hanging wall and back are bolted immediately following a blast to give support during the subsequent scraping, filling, and drilling operations. Bolts are 6 ft long and are installed on 5-ft centers horizontally and 4-ft centers vertically. Push feed drills are used exclusively in these stopes for drilling and rock bolting.

Bolts are installed by regular contract miners and both the slot and wedge and expansion shell types have been used successfully. The expansion shell bolt is ideal in this application, since the ground remains open only long enough for the cut to be made. They may be removed from the back before the blast is made to keep them from falling into the muck pile where they would impede scraping.

Rock bolting has also been applied to square-set stopes with considerable success. When it was noted that the timber in several stopes at the Mt. Con mine had begun to ride and break, 6-ft rock bolts were driven into the hanging wall. This practice was continued for each successive floor. At the third floor apparently all ground movement had ceased. This indicated that a fracture or clay seam, parallel to the plane of the vein, had caused a false hanging wall which was gradually slipping downward as the supporting ore was removed, a common occurrence in Butte ground. In these cases the shear strength as well as the tensile strength of the steel rock bolts was being utilized in keeping this false hanging wall in place.

Rock Bolting Large Excavations Prior to Concreting: The condition of the country rock found in the Butte mines usually necessitates timber support for any large underground excavation. Fig. 5 illustrates a method used to excavate an underground hoist room on the 4000 level of the Mt. Con mine. The excavation was enlarged from two 9x7-ft crosscuts 50 ft long with connecting crosscuts at both ends. The ground was first supported with timber, but when this began to fail, 8-ft rock bolts were driven into the walls and back and the timber used only for staging as the excavation progressed. The room was then entirely concrete-lined. The protruding ends of the bolts reinforce the arched roof slab and were useful in hanging the reinforcing rods. The absence of timber blocking against the ground simplified the placing of the concrete forms.

The Kelley mine 600 level ore pockets are concrete-lined, rail-reinforced, cylindrical excavations with 14-ft diam and 65-ft depth. The pockets were excavated by sinking from the 600 level, a clamshell being used for mucking. The use of 6-ft and 8-ft rock bolts made it unnecessary to timber as the excavation progressed. The cycle followed was drill out, blast, scale down, rock bolt, and muck out. This cycle permitted the use of the muck pile to reach any loose ground opened up by the previous blast. Timbering these pockets would have necessitated special framing and design with resultant higher costs. Also, considerable trouble would have been encountered in placing the forms for the concrete with the timber still in place.

Rock Bolting Development Headings: A large percentage of the development headings in Butte now use rock bolts instead of timber for ground support. Twenty-five hundred feet of the 4400 level at the Mt. Con mine was developed in this manner with an estimated 10,000 tons of waste rock left in place which otherwise would have been broken to make room for regular timber sets.

The wide intersection shown in Fig. 6, part of the vast system of haulageways for Anaconda's new block caving project at the Kelley mine, has been made completely self-supporting by the installation of rock bolts. Timbering an intersection such as this would entail considerably higher costs due to increased material handling and the disposal of extra waste rock broken to make room for this timber. The

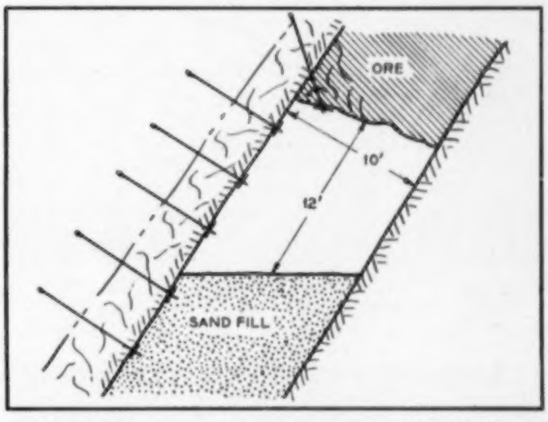

Fig. 4—The rock-bolting procedure used at the Mt. Con mine in stoping by the cut-and-fill method.

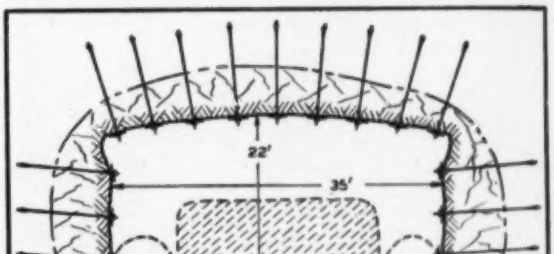

Fig. 5—The rock-bolting method used to excavate an underground hoist room on the 4000 level of the Mt. Con mine.

use of rock bolts makes it possible to drive these headings with the minimum cross-section required for proper clearance of the ore trains. Besides ground support, rock bolts are used to hang trolley lines, pipe, vent tubing, and electrical cable.

Unfortunately, all types of ground in Butte cannot be secured with rock bolts and steel plates alone. Numerous faults, slips, and clay seams at frequent intervals make it necessary to use some means of distributing the support given by the rock bolts over a larger area. War surplus airfield landing mats, shown in Fig. 7, are used for this purpose, as they are easy to install and can be drawn up to conform with the contour of the ground.

Rock bolt sets made of light timber are ideal for repair work in main haulageways not bolted or timbered originally which now require close back and side lagging. They can be installed without interrupting train service, interfering with pipelines, or enlarging to make room for regular timber sets.

These sets, Fig. 8, were installed in 600 ft of haulageway connecting the Badger and Black Rock mines. When the air flow was reversed from fresh to exhaust air, the hitherto firm granite was subjected to rapid alteration at the jointing planes. Overhead safety stringers were advanced as each rock bolt set was installed.

Other Rock Bolt Installations: Rock bolts are ideal for supporting ground in excavations used for housing electrical equipment or storing explosives, since they are fireproof. Timber used in these locations would first have to be covered with wire mesh and then gunited to eliminate the hazard of fire. Fig. 9 illustrates an installation on the 4000 level of the Mt. Con mine housing electrical equipment for a deep level hoist. This room has been open for three years. The ground was badly fractured in places, but there has been no sloughing of the walls or back.

Rock bolts have proved their worth in numerous other underground installations in the Butte mines. These include pumping stations, air conditioning rooms, stations, safety zones, underground repair shops, and locomotive battery change-over rooms.

Besides ground support, rock bolts make convenient hangers for many types of underground equipment. Air and water pipe, electrical cables, see Fig. 10, rigid vent tubing, and ventilating fans are some of the more common uses for this kind of support.

Rock Bolting Practices at Sunshine Mining Co., Kellogg, Idaho

Rocks of the Coeur d'Alene district fall into three groups: 1—Pre-Cambrian rocks of the Belt series; 2—igneous rocks intrusive into the Belt series; 3—unconsolidated sand, gravel, and silt of Tertiary and Quarternary age.

Orebodies of the Sunshine mine occur in shear zones, and along at least one fault, in the north limb of the Big Creek anticline. Upper workings of the mine are in the Wallace formation, and the lowest appear to have entered the Revett. The St. Regis, a thin-bedded argillaceous quartzite lying between the Wallace and Revett, has thus far been the most productive ore-bearing formation of the Silver belt.

Drifts in general strike east and west, the veins and accompanying shearing dipping 70° to the south. The veins occur in shear zones along the steeply dipping north limb of the Big Creek anticline. The bedding in general dips 80° and steeper to the north with occasional slight overturning. The intersecting south-dipping schistosity and north-dipping beds at a maximum angle of 30° produce a weak, slabby, and sometimes blocky hanging wall.

Some four distinct mining methods or modifications of these methods are used at Sunshine in extracting orebodies.

The square-set method is used in orebodies that are 10 ft or greater in width. Stope lengths are generally about 45 ft. The caps are 10x10 in., girts 8x10 in., and posts 9x9 in. All pieces are made from sawed timber. Plan dimensions of each set are 5x5 ft to center line, center line heights being either 6 or 7 ft. Six to seven floors are mined before final cleanout of ore and subsequent filling with waste rock. One floor is left open to begin the next mining cycle. Approximately 46 pct of all ore, except from development headings, is mined by this method.

The method employing caps and stull posts with the caps headed perpendicular to the dip of the vein are used in stopes where the vein is less than 10 ft wide. Cap dimensions may vary from 10x10-in. to 12x12-in. timbers with 6x8-in. post lengths sufficient to give floor heights of 5-ft or 6-ft centers. Caps are headed with 6 to 8 in. of heading. Ore is broken by breasting down. Stope lengths are comparable to the square set. Floor heights and timber dimensions are governed by ground conditions. Here again, six to seven floors are mined before cleaning and filling with waste. The last floor is left open to begin the next cut.

Timbered shrinkage is used where ground conditions are good. This method is comparable to the cap-and-stull system except that 75-ft to 80-ft heights may be mined before cleaning and filling with waste. Back stoping is generally used with this method and stope lengths are also held to 45 ft.

By substitution of rock bolts for timber numerous stopes have been successfully mined on a full shrinkage basis, rock bolts being used to hold the hanging wall and in one instance to bolt the footwall. Stope widths must be no less than 7 ft so a 6-ft bolt, which is standard length for stopes, can be installed.

Early in 1952, through courtesy of the Engineering Research Dept., Anaconda Copper Mining Co., a systematic study was made of methods and techniques used in rock bolting. To date, 12,700 bolts including 11,050 6-ft bolts, 1100 4-ft bolts, and 315 8-ft bolts, together with 235 experimental bolts, have been installed with most gratifying results.

The bolt most commonly used is the 1-in. diam, 6-ft split-wedge type. However, tests have proved that equally good results can be expected from the use of the ¾-in. expansion shield type. These bolts are being used in increasing numbers and no doubt will eventually replace the split-wedge type.

Split-wedge bolts are driven by means of a dolly and driving steel and then tightened to refusal with a 534I-R impact wrench. Fig. 11 shows a member of the rock bolting crew catching up loose ground. The only accessory tool for the expansion shield type is an impact wrench. Most rock bolt holes are drilled with 1⅜-in. insert bits by contractors and regular rock bolt crews, of which there are three currently employed. However, the split-wedge bolt has been used successfully in 1⅝-in. holes.

Now that rock bolts have been used for two years, it is assumed that where a bolt can be firmly anchored it will hold the ground firmly in place. Bolting of unstable rock sections of drifts and crosscuts has been done extensively. Fig. 12 is an illustration.

Numerous stopes have been mined with rock bolts to lend strength to the hanging walls. In driving

Fig. 6—This intersection in a system of haulageways has been made completely self-supporting by the installation of rock bolts.

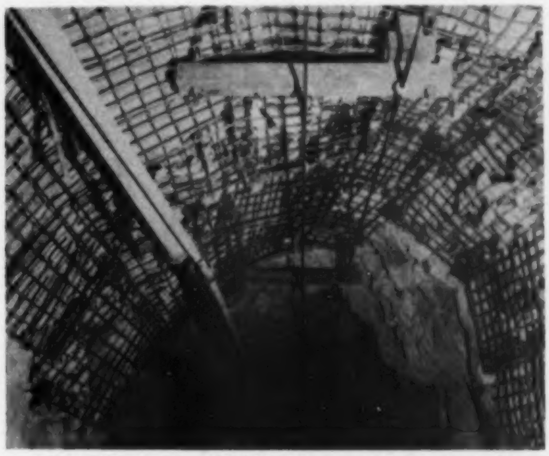

Fig. 7—War surplus airfield landing mats, shown above, distribute over a larger area the support that is provided by rock bolting.

Fig. 8—Rock bolt sets of light timber are ideal for repairs in main haulageways not bolted or timbered originally.

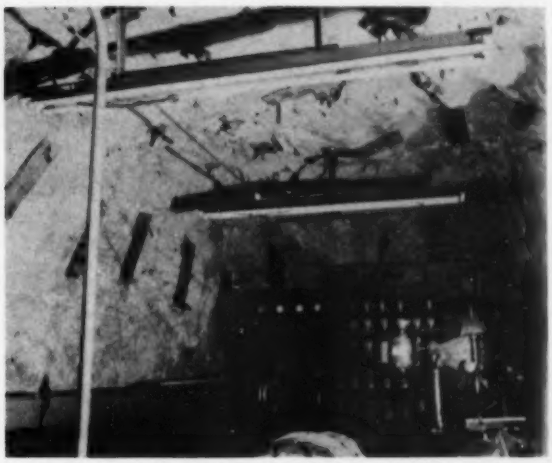

Fig. 9—Rock bolt installation on 4000 level of Mt. Con mine housing electrical equipment for a deep level hoist.

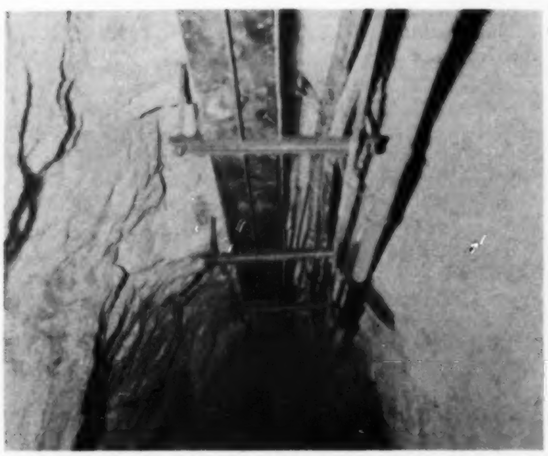

Fig. 10—As shown here and also in Fig. 12, rock bolts provide convenient hangers for air and water pipes and for electrical cables.

Fig. 11—A member of the rock bolting crew catching up loose ground. Expansion shield bolts are applied with an impact wrench.

Fig. 12—Here, as in Fig. 10, rock bolting serves a dual purpose.

of raises, rock bolts in the hanging wall between the timber pattern have been valuable aids. Shaft stations, grizzly stations, battery stations, and drift and crosscut junctions are bolted as an aid in development and exploration programs. An established practice in crosscut and drift headings is the installation of 4-ft rock bolts from which to suspend rigid ventilating fan lines. Repair work in shafts and winzes is expedited by the use of rock bolts.

There is often a question as to the economic advantages of rock bolting as compared with conventional methods of timbering. With ever increasing labor and material costs, this question is of paramount importance to metal mine operators. The cost, delivered in Kellogg, Idaho, carload lots, of the split wedge and expansion shield bolts is given below, see Table III.

Table III. Comparative Costs of Split-Wedge and Expansion Shield Bolts

Split-Wedge Bolt, 1-In. Diam		Expansion Shield Bolt, ¾-In. Diam	
Length	Cost, $	Length	Cost, $
8-ft bolt with wedge and nut	1.72	6-ft bolt with shield	1.15
6-ft bolt with wedge and nut	1.36	4-ft bolt with shield	0.91
4-ft bolt with wedge and nut	1.04		

Plates 8x8x⅜ in. with 1¼-in. hole are purchased in Spokane at a delivered price of $0.47 each. Angle washers, 15° and 30°, cost $0.22 each.

Recently a crosscut on the 3400 level cut the Yankee Girl vein. After drifting westward for some distance, the back became so weak drift sets had to be installed.

This was done at a total labor and materials cost of $8.51 per linear foot. A comparable section was rock-bolted, using the 6-ft split-wedge type, at a labor and complete bolt cost of $4.82 per ft. This represents a saving of 43.5 pct, not to mention excess rock removed for timbering and the large quantity of heavy timber transported to the working place as compared with the less bulky rock bolts, plates, and wedges, and the uninterrupted advancing of the drift. This drift has since been bolted throughout its entire length. Drifts and cross-cuts that lie in potential rock burst areas have been bolted to impede rock falls. There has been no failure or any observed weakness.

Rock bolting of shrinkage stopes presents an economical approach to ore extraction. As previously stated, 7-ft minimum widths must be maintained. The average width of all the bolted shrinkage stopes has been 11 ft. Stope lengths are held at 45 to 50 ft and stope heights terminate at 90 to 100 ft. Enough ore is drawn after blasting to bolt the hanging wall and back stope or breast down another cut. During blasting the effectiveness of a very small percent of the bolts is lost by breaking of the hard quartzite rock from around the bolt plate. An additional bolt or bolts are installed to replace those damaged. As these stopes are not always bounded on their strike length by raises, a follow-up manway may be timbered as the stope is advanced in height, or the manway may be timbered as the stope is drawn. The adjacent block of ore may then be mined before another raise is driven. Additional bolts, depending on the need, may or may not be installed as the stope is drawn for waste fill. Seven stopes have been mined by this method. Data for five stopes are summarized in Table IV. These five stopes represent a total of 20,608 tons of ore.

Table IV. Summary of Data for Five Stopes

Stope	Tons Per Manshift	Tons Per Rock Bolt	Square Feet of Wall Per Rock Bolt	Cost Per Ton of Installed Rock Bolt, ¢
3700 to 811	12.2	9.7	8.9	36.6
3700 to 910	14.5	12.8	21.1*	27.5
3400 to 14	10.1	18.3	14.0	19.5
3400 to 11	10.8	11.8	12.2	30.4
3400 to 10	7.1	18.4	18.3	19.3
Avg of stopes	10.6	13.8	15.2	25.7

* Footwall and hanging wall bolted.

It may be of interest to compare the above average of the rock bolt shrinkage stopes to a timbered shrinkage stope recently completed. From a timbered shrinkage stope 3991 tons of ore were broken with a productivity of 7.7 tons per manshift. Timber and contract labor cost $0.55 per ton. Slightly more than 20,000 board feet of timber had to be transported to the timbered shrinkage stope. Whereas the average productivity per direct manshift in stoping is 6.8 tons for the mine, the rock bolt shrink stope is nearly 4 tons greater and that of the timbered shrinkage stope approximately 1 ton greater.

It is apparent that use of rock bolts in shrinkage stoping has shown a marked economic advantage of 53 pct over the timbered shrinkage stopes.

Rock bolts have been used extensively in the two cap and three cap development raises. One bolt is driven near the hanging wall heading and one near the center of the set. The pattern appears as the five dots on dice. Occasional bolts in the footwall are

used to stabilize rock that may give trouble. The value of this bolting procedure is readily apparent in repair of raise timbers. One large square-set raise, 20 ft square, was driven from 3700 to 3550. The pattern described was followed on all four walls of the raise. The bolts increased the useful life of this raise severalfold. These raises were driven with stopers using 1⅝-in. insert bits. One-inch diameter slot and wedge type bolts were used. There was no difficulty in obtaining a solid anchor.

Shaft stations, hoist stations, grizzly stations, and battery stations are systematically bolted. Fig. 13 shows a 30x40-ft enlargement for 3700 No. 8 shaft station. These places are bolted to give maximum support rather than to follow fixed patterns. Particular attention is given brows, which develop weakness rapidly. This is especially important in areas where rock bursts may occur.

Since rock bolting was first employed at Sunshine Mining Co. many helpful techniques have been obtained from mining magazines, manufacturers of rock bolts, and Bureau of Mines personnel; however, every mine has unique problems that do not conform with methods employed in other mines. These problems are best worked out by the individual mines to their satisfaction.

Conclusion

In the search for an economic advantage in extraction of orebodies over the increasing costs of labor and supplies, it is of prime importance that established mining methods be supplemented with suitable mining aids to gain this end. Seldom is one unfamiliar with rock bolting impressed by this method, but those using rock bolts give them an important place in their mining operations.

The criterion for judging any new mining technique an improvement over existing methods is: Will it do the same job faster and cheaper? The merits of rock bolting have been proved by this standard.

Fig. 13—Rock bolting in a 30x40-ft enlargement for a shaft station on the 3700 level.

Experience has shown that higher productivity and a more economical unit cost can be realized by the use of rock bolts in shrinkage stopes.

Since rock bolts may be applied immediately to the existing shape of the excavation, rock bolting is faster than timbering, which necessitates framing the timber to conform to local ground conditions. Five rock bolts will normally support as much ground as a set of timber, yet their cost is approximately one half that of the timber. A bundle of 10 rock bolts can be stored or transported underground to the working place with the same effort required for only one piece of timber.

In view of these facts the mining industry, the steel industry, and the U. S. Bureau of Mines have put forth a great deal of effort in promoting rock bolting as a method of ground support. Much progress has already been made and the future will no doubt reveal many new applications which have not yet been considered.

Latest Practice in Burning Cement and Lime In Europe

by O. G. Lellep

Modern shaft kilns in Europe are fully mechanized and burn cement of acceptable quality at 700,000 Btu per bbl and lime at 3.2 million Btu per net ton. Rotary kilns for cement have increased in thermal efficiency by using exit gas heat for preheating incoming raw material and by recovering heat from outgoing clinker in air-quench coolers. The dry process Lepol or ACL kiln has the lowest fuel consumption, 580,000 to 630,000 Btu per bbl, and very low dust loss, about 1 pct weight of clinker. The Holdebank-Gygi system reaches 720,000 Btu per bbl. The calcinator kiln for the wet process consumes 1.1 million Btu per bbl.

IN every country economic circumstances prescribe the method used to produce a commodity at lowest cost. In Pennsylvania a man's wages for working 4 hr buys a ton of coal wholesale; in Germany a laborer must work 40 hr, or ten times as long. In western Europe, therefore, conservation of fuel is of primary importance, and recent practices of burning lime and cement differ from those employed in the United States. This paper presents data collected during a trip through western Europe in 1953.

Considered uneconomical, shaft kilns for burning

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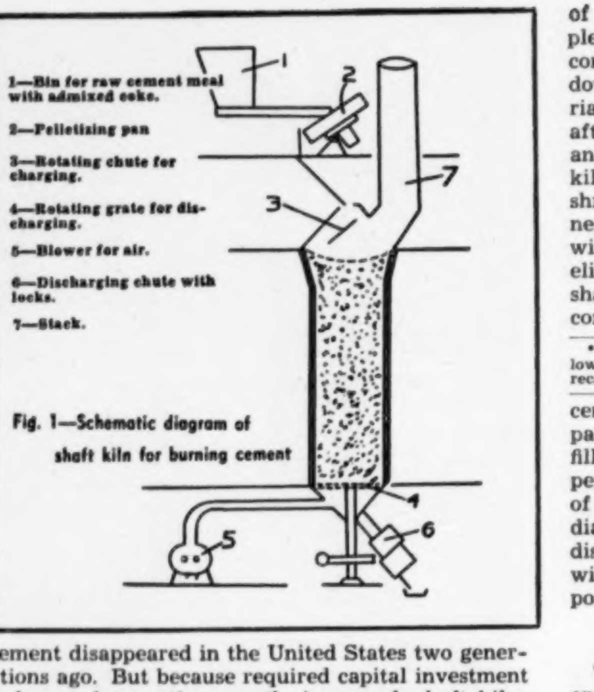

Fig. 1—Schematic diagram of shaft kiln for burning cement

cement disappeared in the United States two generations ago. But because required capital investment is low and operation greatly improved, shaft kilns are still used to some extent in Europe, where fuel costs are high, and are even included in designs for plants under construction. During the last 50 years shaft kilns have been maintained at the same physical size, while their output has been increased at least four times.

The kiln charge, which formerly consisted of large 10-lb briquettes, has been replaced by a relatively small-grained feed of raw meal and crushed coal made in balling drums, or pans, or in pug mills. Positive high-pressure blowers and fully automatic charging and discharging equipment is used. The quality of cement burned in improved shaft kilns meets modern specifications in carefully managed and controlled plants, although a uniformly burned product is harder to obtain in shaft kilns than in rotary kilns, which produce by far the largest part of the general output.

Fig. 1 is a sketch of a modern shaft kiln for cement. The top of a kiln for cement has a conical, widened zone introduced by E. Spohn. Combustion of admixed fuel and a sintering of product is completed mainly in this top section. The charge shrinks considerably during the sintering process and moves downward. The large diameter of unburned material in the zone at the top of the cone diminishes after sintering to the narrower diameter of the shaft and fills the space near the periphery. In older shaft kilns the shaft was cylindrical; consequently after shrinkage due to sintering a free slot was formed near the wall which allowed red hot gases to escape without being utilized. E. Spohn's cone shape has eliminated this defect and the exit gas of a modern shaft kiln in normal operation is below 200°F. Fuel consumption is around 700,000 Btu* per bbl of cement. The usual inside diameter of the cylindrical part is 8 ft and the effective height to which it is filled about 25 ft. Such a kiln can produce 1000 bbl per 24 hr and sometimes more. However, the output of cement shaft kilns remains fairly limited. If the diameter of the shaft is made larger, the uniform distribution of fire and temperature through the wide cross-section becomes difficult and almost impossible to control.

* In Continental Europe heating value of fuels is expressed in lower units, i.e., in net calories. In this report European data are recalculated as gross Btu.

Thermal Efficiency and Rotary Kilns

The rotary kiln is essentially an American development. It is remarkable for its adaptability in burning various mineral, chemical, or ceramic products and today is unsurpassed for high quality, uniformity of burn, and large output. Twenty-five years ago the rotary kiln was extremely wasteful in fuel consumption. Frequently red hot exit gas came out of the stacks and white hot cement clinker was thrown on the clinker pile. Fuel consumption in these older kilns was around 2 million Btu per bbl, or about three times as high as with the best modern practice. During the last generation radical improvements have been made to cut waste of heat at both ends of the rotary kiln. Waste heat at the feed end of the kiln was utilized to produce steam for power generation. Preferably this available heat now is saved to preheat the incoming raw mixture. A rotary drum air-swept clinker cooler has been introduced at the discharge end to cool the white hot product and return the recovered heat as hot air for combustion. Power production from waste heat boilers behind cement kilns is still used in some instances, but the large and more efficient power com-

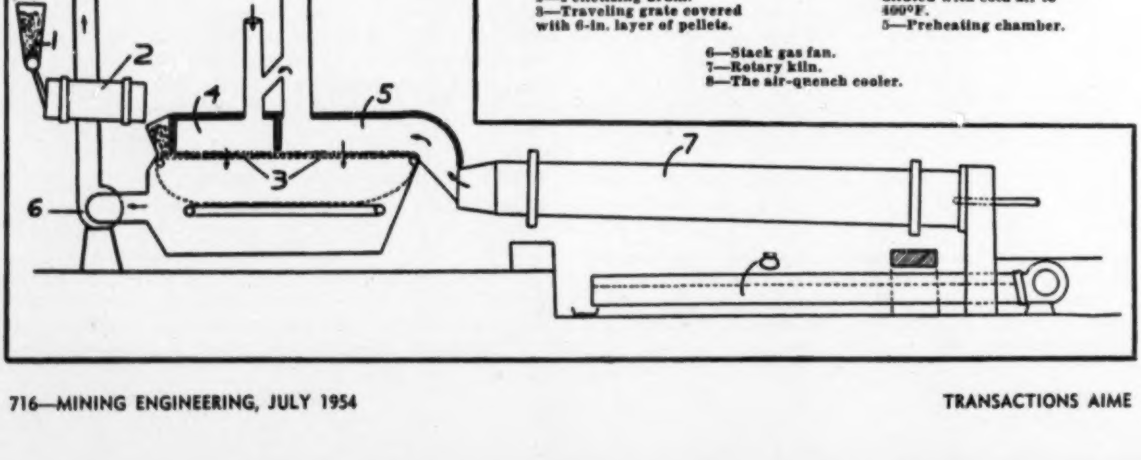

Fig. 2—Prewar Lepol kiln with single pass for gas.

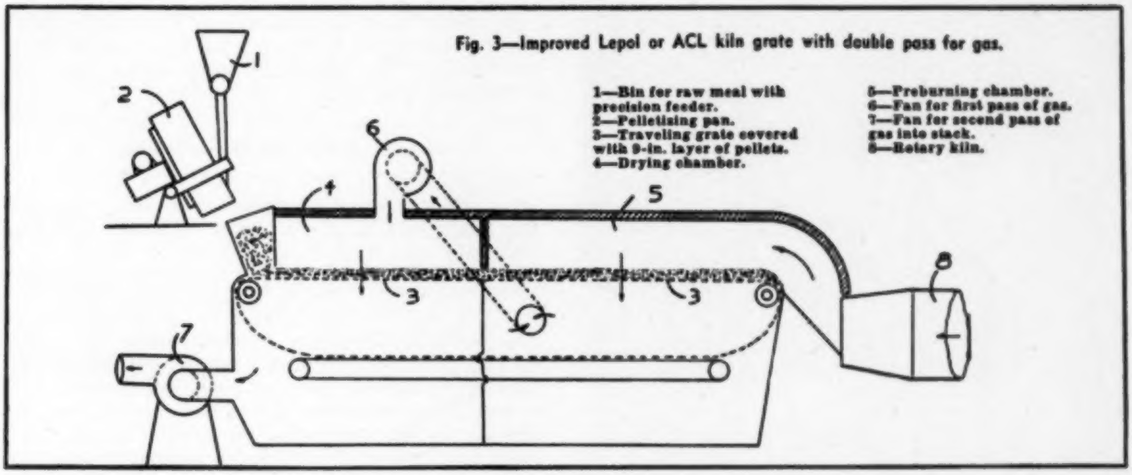

Fig. 3—Improved Lepol or ACL kiln grate with double pass for gas.

1—Bin for raw meal with precision feeder.
2—Pelletizing pan.
3—Traveling grate covered with 9-in. layer of pellets.
4—Drying chamber.
5—Preburning chamber.
6—Fan for first pass of gas.
7—Fan for second pass of gas into stack.
8—Rotary kiln.

panies can usually supply power cheaper than that made from waste heat.

Twenty-three years ago the single-pass prewar Lepol kiln, Fig. 2, was introduced. Instead of generating steam, the exit gas heat is transmitted into a layer of pelletized incoming raw mix and is thus utilized more efficiently. The length of the rotary kiln was cut to from one-half to one-third. Fuel consumption per barrel for dry process cement was decreased to about 700,000 Btu per bbl. One hundred twenty of these kilns were sold in various parts of the world prior to World War II.

This kiln system has been improved in the postwar period, and fuel consumption has been lowered still further. More particulary, passing the kiln gases twice through the layer of pellets has decreased losses radically. Fig. 3 is a schematic diagram of the improved post-war double-pass Lepol or ACL kiln* and Fig. 4 an outside view. The second pass of gas through a layer of moist pellets not only lowers exit gas temperature close to the dewpoint of 160°F, but also filters out more dust than a cyclone can filter. During the last 2½ years 23 improved Lepol grate installations have been sold. Table I gives data from four new plants that began operation in Germany and Sweden in 1952 and 1953.

The best consumption in the long modern dry and wet process kilns of conventional design is about 0.8 million Btu per bbl. Output of cement in barrels per cubic foot of internal rotary kiln volume in the Lepol and ACL system is twice or more that in the kilns of conventional design.

The dust from dry process cement kilns without expensive Cottrell dust precipitators usually varies between 3 to 10 pct of the weight of clinker. The improved Lepol kilns employ a dust cyclone after the first pass of gas. No cyclone is normally used after the second pass or before the stack. After the second pass in the ACL kiln system where the exit gas is filtered through a layer of moist cement pellets the dust averages 1 pct of the weight of clinker. Thus a double-pass ACL grate not only saves heat, but also collects dust more efficiently than a cyclone.

Normally the wet process cement slurry of noncolloidal materials can be filtered rapidly to about 17 pct moisture on a drum-type filter. In exceptional cases it is possible to lower the moisture content to 14.5 or 15 pct moisture by beating the filter cake on the drum with so-called flappers. Such a filter cake can be pelletized and burned in the Lepol (ACL) kiln system.[1]

One double-pass Lepol plant reports a power consumption of 2.66 kw-hr per bbl of cement produced, including coal grinding. Operating time in another plant has been 90 to 95 pct of ideal plant operating time. Fig. 4 is a view of the Lepol installation, which went in operation in 1953.

The calcinator, built by the Miag Co. in Germany, is used in large numbers on wet process kilns and also to some extent on dry process kilns to reduce heat consumption. It is a heat-exchanger consisting of a slowly rotating drum, 13 ft in diam by 10 ft long, with a perforated cylindrical shell, and is filled with large pieces of rolling heat-exchanger members, such as cutoff pieces of 4-in. pipe, or I-beams. The hot exit gas is passed through the rolling layer of heat-exchange bodies while the cement slurry is sprayed on the top surface of the rolling heat-exchanger.

E. Schott,[2] Table II, reports the following data about a wet process calcinator, 13 ft in diam by 10 ft long. The kiln is 10.5 x 175 ft long.

* *Lepol* and *ACL* are trademarks of a kiln of the same system. The Lepol kiln is marketed by Polysius Co., Neubeckum, Germany, and the ACL kiln by Allis-Chalmers Manufacturing Co.

Table I. Operation Data for Four Lepol Kiln Plants in Germany and Sweden

Designation of Installation	Rated Output, Bbl Per 24 Hr	Average Output Over 5-Month Period, Bbls Per 24 Hr	Heat Consumption Measured During a 24-Hr Test Period, Btu Per Bbl	Average Heat Consumption Over a 5-Month Period, Btu Per Bbl	Reported Dust Loss into Stack, Pct from Clinker
1	3000	3480	595,000	630,000	1.5
2	3000	3400	570,000	600,000	Very little
3	1800	2100	580,000	Below 630,000	0.81
4	1800	No data yet	595,000	No data yet	0.7

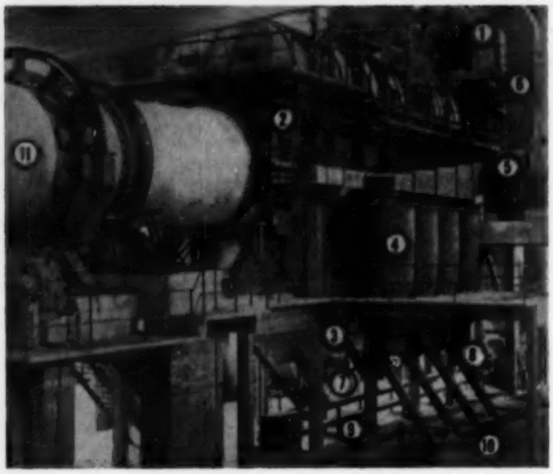

Fig. 4—View of the two-pass Lepol grate built by Polysius Co.

1—Balling or pelletizing pan.
2—Upper part of furnace.
3—Lower part of gas chambers built of concrete.
4—Cyclone for dust after first pass of gas through the pellets.
5—Fan for first pass of gas.
6—Gas duct leading into the predrying chamber.
7,8,9, and 10—Enclosed chutes and transporting devices taking dust into rotary kiln.
11—Rotary kiln.

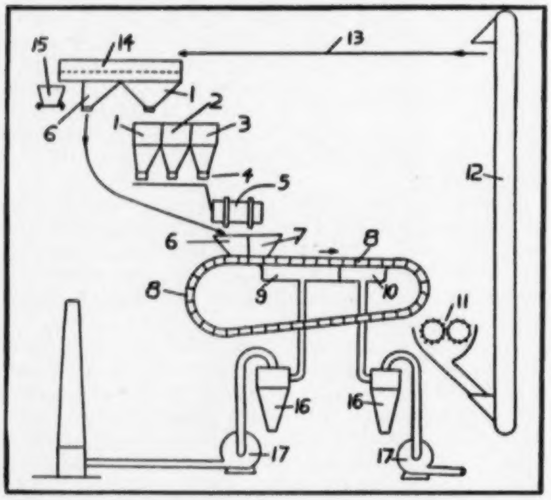

Fig. 5—The Lurgi-Wendeborn sintering process for cement.

1—Bin for recirculated burned fines.
2—Bin for raw meal.
3—Bin for coke breeze.
4—Automatic proportioning scales.
5—Pelletizing drum.
6—Screened clinker to protect grate.
7—Bin for pelletized feed.
8—Sintering machine.
9—Suction box for stack gas.
10—Suction box for hot gas used for predrying raw material.
11—Crusher.
12—Elevator.
13—Conveyor.
14—Screen.
15—Good, coarse clinker.
16—Cyclones.
17—Fans.

Mention should be made of the Kloeckner-Humboldt cyclone heat-exchanger for dry process kilns; four kilns of this type were operating in Germany in the summer of 1953.

Table II. Data for Wet Process Calculator

Size of Calcinator: 13-Ft Diam x 10 Ft Long	Kiln Output, Bbls Per 24 Hr	Exit Gas Temperature, °F	Heat Consumption, Btu Per Bbl
Before installation of calcinator	1920	1400	1,510,000
After installation of the calcinator	2000	270	1,116,000

The Holderbank-Gygi heat-exchanger was developed in Switzerland over 10 years ago. A few are running in that country and two in Sweden, but none in Germany. Tham and Sylvan[3] of Skanska Cement Co. have reported on this system. To improve heat transmission by conduction from the hot gas to the raw mix inside the feed end of the kiln, the gas is caused to rotate at a higher velocity in a spiral movement. Four turbine-type windmill wheels of heat-resisting metal are fixed to the inside wall of the kiln. Lifters are bolted to the inside kiln wall between the turbine wheels. They lift the nodulized raw mixture and drop it through the hot gases, thus increasing the heat-receiving surface of the material to be heated. Two older wet process kilns have been converted to this system in Sweden; Table III shows the dimensions, outputs, and fuel consumption.

The lifting and dropping of pellets in this heat-exchanger causes considerable dust, which is precipitated and re-utilized in the Lepol system. Besides the improved rotary clinker cooler used on most prewar Lepol kilns, modern kilns preferably use one of three well-known air-quenching coolers.

The process of burning cement on sintering machines, invented by an American, R. W. Hyde[4], was developed through long years of work in Germany by H. Wendeborn[5] of the Lurgi Co., successfully operated by K. Boerner, and further improved by R. Rohrbach.[6] Fig. 5 is a diagram of a Lurgi cement-burning plant with a sintering machine. Numerous tests have shown that a more acceptable product results if in addition to raw cement mixture and crushed coke 30 to 60 pct of feed to the machine is already burned clinker. An accurate proportioning between the raw mixture and the fuel is important, requiring reliable automatic scales. It appears difficult always to burn the layer on the grate to a perfectly and uniformly well-burned clinker, an objective relatively easy to obtain in a rotary kiln. Therefore it is necessary to crush the burned layer and screen out the underburned part, which is returned into the circuit and mixed with the raw feed. To prevent overheating, the grate bars have to be protected with a layer of already burned clinker.

According to Rohrbach[6] a plant with an active grate area, 6.5 ft wide by 43 ft long, produces 2000 bbl per 24 hr. Toal heat consumption in the ignition

Table III. Data on Conversion of Wet Process Kilns to Dry Process Holderbank System

No. of Kiln	Length of Kiln Including Cooler, Ft	Diameter of Kiln: Feed End	Diameter of Kiln: Burning Zone	Output When Run on Wet Process, Bbl Per 24 Hr	Output After Conversion to Dry Process Holderbank System 24-Hr Test, Bbl Per 24 Hr	Heat Consumption
1	290	9 ft 4 in.	8 ft 5 in. x 10 in.	1800	1950 est.	720,000
2	290	10 ft 5 in.	9 ft x 10 in.	2200	2450	actual input

flame and admixed carbon amounts to 810,000 Btu per bbl over long periods of operation. Good cement quality has been produced by this burning equipment, provided the equipment is well maintained, supervised, and controlled.

Lime and Dolomite Burning

Because of high fuel cost, lime is burned in shaft kilns only in Germany and France. Rheinische Kalkwerke at Wuelfrath has a set of six shaft kilns of the Seeger design, apparently operated at an excellent fuel efficiency, see Fig. 6. Inside diameter is 12.8 ft and wall thickness 20 in. Wall thickness of six new shaft kilns of improved design has been increased to 30 in. by means of insulation. The cylinder is filled with stone and lime to a height of 57 ft. Two sizes of stone are burned: 2⅜ to 4¾ in. and 4¾ to 7 in. Output for the smaller size of stone is 135 tons per 24 hr per kiln and for the larger size 120 tons. Charging and discharging is fully mechanized. Three men can operate six kilns if they need not be concerned with stone supply.

To avoid segregation, particular attention is paid to the uniform distribution of stone and coke in these mixed feed kilns. Water-gage pressure required to move the gases through the kiln varies from 2.35 to 4 in. The results obtained are remarkable. The lime is discharged cold and the top gas temperature is only 212°F. The gas analyzer registers a steady 41 pct carbon dioxide and a scarcely noticeable carbon monoxide content. Heat consumption is reported as only 3.2 million Btu per net ton of lime burned.

In the older system of charging these kilns the skips of stone were charged on top of the kiln, and thereafter a separate skipload of coke was distributed on top of stone inside the kiln. It was difficult to distribute coke uniformly on the layer of stone because of poor visibility inside the kiln. In the new system of charging the round, the rotatable skip for charging is first filled with stone while on the ground floor, and thereafter a uniform layer of coke is very carefully and evenly distributed on top of the stone in the skip on the ground floor. There the operator can see and control the fuel distribution.

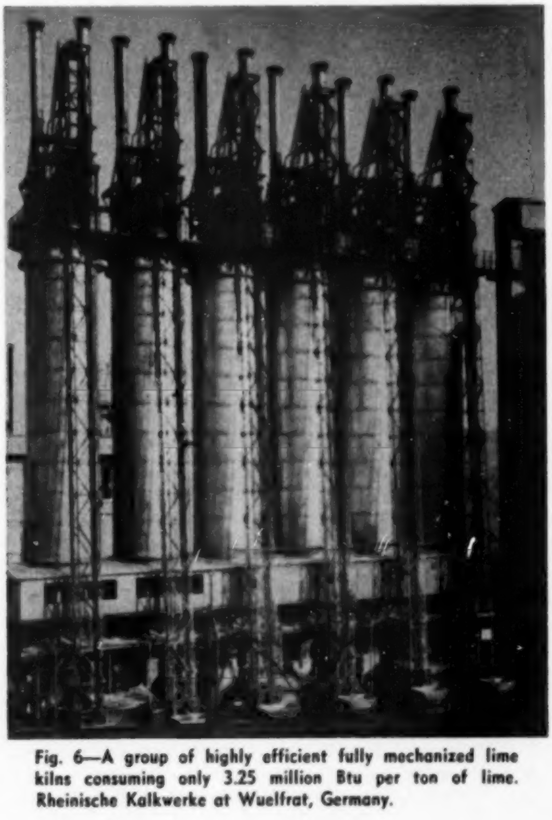

Fig. 6—A group of highly efficient fully mechanized lime kilns consuming only 3.25 million Btu per ton of lime. Rheinische Kalkwerke at Wuelfrat, Germany.

Fig. 7—Shape and relative size of pellets formed in pelletizing drum or pan of cement raw mixture.

The largest part of the dead burned dolomite required as refractory material in the steel mills is still burned in mixed fuel-fired shaft kilns. Limestone spalls, or stone from 2 to ¼ in., cannot be burned efficiently and with sufficient output in a normal shaft kiln. The known authority on industrial furnaces, W. Heiligenstaedt, is building a patented gas-fired shaft kiln for this purpose. It has two narrow rectangular stone and lime-filled shafts, each 26 ft high by 17 ft long and only 25 in. wide. The gases are recirculated crosscurrent instead of countercurrent, in three passes through the thin layer of stone. Estimated output is 100 metric tons per 24 hr.

Conclusions

Owing to war damage and lack of capital most cement and lime plants in western continental Europe need modernization, but a number of plants mentioned in this report remain the leaders in efficient fuel utilization and competent management.

The above data were obtained from sources considered reliable; however, the writer cannot be responsible for their accuracy.

References

[1] Both the Lepol and ACL systems are based on O. G. Lellep patents.

[2] E. Schott: *Test of Cement Burning Equipment Used in Germany*, pp. 117-175. Report presented at Meeting of German Portland Cement Association, May 5, 1953.

[3] L. H. Tham and P. Sylvan: Producing Cement Clinker at Less than 700,000 Btu per Bbl. *Rock Products* (September 1953) pp. 78-87, 124-126.

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Application of Closed-Circuit TV to Conveyor And Mining Operations

by G. H. Wilson

INTRODUCED in 1946 to serve a need in power-plant operation, closed-circuit TV has been used by well over 200 organizations in approximately 25 different industries. Known as industrial television, or simply ITV, it can be described as a private system wherein the television signal is restricted in distribution, usually by confinement within coaxial cable that directly connects the TV camera to one or several monitors, Figs. 1, 2. The picture is continuous and transmission is instantaneous, permitting an observer to see an operation that may be too distant, too inaccessible, or too dangerous to be viewed directly. Destructive testing or the machining of high explosives can now be conducted hundreds of feet away by personnel who still have close control through the eyes of the TV camera. It is also possible for one man to control operations formerly requiring the co-ordinated efforts of several workers. For example, at a large midwestern cement plant conveyance of limestone from primary crusher to raw mill and loading into five storage bins once necessitated the work of two men, one having little to do but prevent spilling of material by manually moving the tripper on the belt conveyor as occasion required. TV cameras mounted on the tripper now provide bin level indication to the conveyor operator at the crusher position so he is able to control the entire loading operation remotely, Fig. 3. By means of a switch, the picture from either camera is alternately available on a single viewer, or monitor, Fig. 4. Each camera is mounted on the tripper by means of a simple adjustable support and looks down into the bin, which is identified by the number of cross members on the vertical rod. Each associated power unit is located on a platform above the camera, Fig. 5. This centralized control by means of TV often has produced superior results, and in many instances saving in operating costs has been sufficient to write off equipment costs within six months to a year.

Where a key portion of a process may be enclosed or otherwise inaccessible, TV again reduces the likelihood of mistakes and permits closer control by making available to the operator valuable information he might otherwise never possess. An example of this can be found at a strip mine where the coal seam lies 50 ft or more below the overburden, which is removed by a large wheel shovel. From his centrally located position the shovel operator was unable to judge accurately to what extent the wheel buckets engaged the earth. His chief indication of efficiency was the amount of overburden on the belt

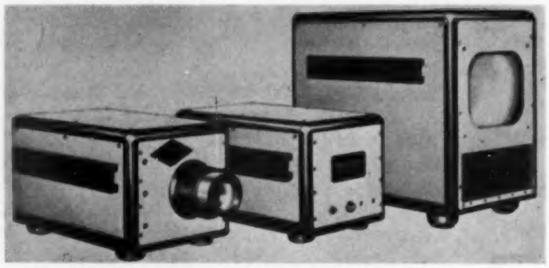

Fig. 1—Basic industrial television equipment: left to right, TV camera, associated power unit, and viewer or monitor. Equipment is designed for continuous operation.

conveyor as it passed his control point 75 ft from the wheel. Now, two television cameras mounted on the tip of the boom permit the operator to view the wheel from each side and provide him with a close-up view of the buckets so that he can take immediate and continuous advantage of their capacity, quickly compensating for ground irregularities and avoiding obstructions, Fig. 6.

While the word *television* conjures up visions of highly complex and intricate apparatus such as that employed in modern TV studios and transmitting stations, the term *industrial television* should indicate compact, straightforward equipment. Most present-day ITV systems contain fewer than 25 tubes including camera and picture tubes. The average home television receiver alone requires at least that many tubes.

Equipment like that illustrated in Fig. 1 contains only 17 tubes, of which 3 are in the camera. It can operate continuously and dependably, without protection, in any temperature from 0° to 150°F. It consumes less current than a toaster and weighs under 140 lb. Camera and monitor may be separated by 1500 to 2000 ft and by greater distance with additional amplification. This equipment is designed to withstand vibrations up to ±1/16 in. and will operate successfully under more severe conditions of vibration and heat when suitable enclosures are provided. Any number of cameras may be switched to a single monitor, and any number of monitors, within reason, used simultaneously.

Two types of applications in the mining industry have already been described. A third under serious consideration by several organizations will make use of ITV for remote observation of conveyor transfer points at copper concentrating plants so that evidence of belt breakdown and plugging of transfer chutes can be spotted immediately and costly overflow of material avoided.

A television camera will soon be installed to view a trough conveyor near the exit of an iron-ore crusher to indicate clogging of the crusher as evidenced by reduction or absence of material on the

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belt. Other means, both electrical and mechanical, have been tried without success.

Another mining organization is concerned with the potential danger to personnel which exists in connection with remotely operated manskips. Engineers have suggested use of a television camera in the cage to let the operator know unmistakably when it is safe to put the hoist in motion without danger to personnel.

In a mine shaft a TV camera has been installed viewing two sheave wheels. This provides the control operator 1500 ft away with a positive and safe means of knowing when cables disengage from the wheels, enabling him to stop operations in time to avoid an accident and prevent damage to equipment. The need for observation is sufficiently critical to have required direct observation by an individual whom the camera has relieved for productive work.

Demonstration has proved that closed-circuit TV can be used successfully to view the interiors of cement kilns. Its use will permit remote control of 6 to 10 kilns by one highly trained operator, greatly facilitating product uniformity, improving working conditions, and at the same time reducing operational costs.

It is reasonable to conclude that the current trend toward use of remotely controlled drilling equipment will eventually give rise to the need for ITV so that proper visual control can be afforded. Although engineering difficulties are numerous, several organizations have become interested in the possibilities.

To evaluate more fully the feasibility of television for a given application it is essential to know the capabilities and limitations of the several types of camera tubes currently available for ITV equipment. As the camera tube is the heart of any TV system, its capabilities and limitations become, in a general sense, those of the system itself.

The image dissector camera tube was the first tube used for this purpose. Because it contains no filament or electron gun, or in other words because it works on the *cold-cathode* principle, it has an extremely long life and is guaranteed for 8750 hr of operation. Image dissectors installed as far back as 1947 are in continuous operation today even after 54,000 hr of service. The dissector, illustrated in Fig. 7, has limited sensitivity, however, and at least

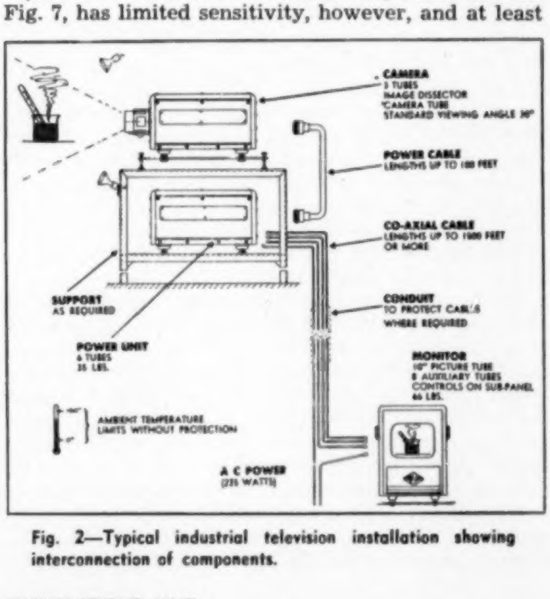


Fig. 2—Typical industrial television installation showing interconnection of components.

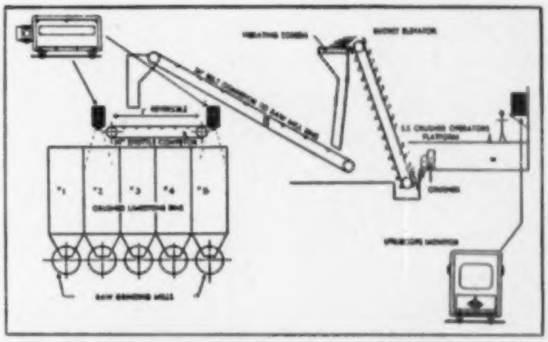


Fig. 3—Diagram above shows how it is possible for one operator to load limestone in storage bins by remote control.

150 foot-candles of illumination are required for a satisfactory picture. While it is not currently practical to design this tube to produce a high-definition picture, it is capable of producing sufficient detail for most industrial applications encountered thus far. Further, since it is a cold-cathode tube it is highly stable, requiring only slight adjustments, and is especially suitable for applications involving continuous operation. Because it is free from the *memory effect* encountered in other types of camera tubes, it is well suited to applications where rapid motion is encountered. Its freedom from *blooming* becomes an important factor where high light levels or sudden surges of light are encountered, as in various types of industrial furnaces.

A more recent introduction is the Vidicon camera tube, diam 1 in. and length 6¼ in. The Vidicon is capable of producing a television picture having greater detail than that produced by the dissector. Although it is subject to memory effect when light levels are low, its sensitivity is greater than that of the dissector to the extent that it can produce acceptable pictures with illumination as low as 25 ft-c, even as low as 10 ft-c in some instances. Life expectancy of the Vidicon is tentatively considered to be from 2000 to 4000 hr. It is currently guaranteed for only 250 hr, however, and for all but the first 15 hr of that total on a pro-rate basis.

Recently several other types of camera tubes have been announced, all operating on the same principles as the Vidicon, with similar capacities.

The image Orthicon, long the only tube used in TV studio work, is too critical and its associated equipment too complex to be considered for closed-circuit industrial work. Although it is eye-sensitive and can produce acceptable pictures at light levels as low as 1 ft-c, its life expectancy of approximately 1200 hr would make operating costs prohibitive for general industrial application.

From this it becomes apparent that type of service, severity of operating conditions, available illumination, and definition requirements are the main factors leading to the choice of a system.

Since the TV camera must often be located at a point where dust, dirt, heat, and vibration, either separately or in combination, are abnormally severe, protective devices usually become an important part of the installation. Many types have been designed to provide adequate protection under the wide range of conditions encountered thus far.

Considerable work has been required to develop special windows which shield furnace-viewing cameras against temperatures approaching 2500°F. Dustproof and explosion-proof housings have been

Fig. 4—Bin level information is received on television screen by crusher operator who controls loading mechanism remotely.

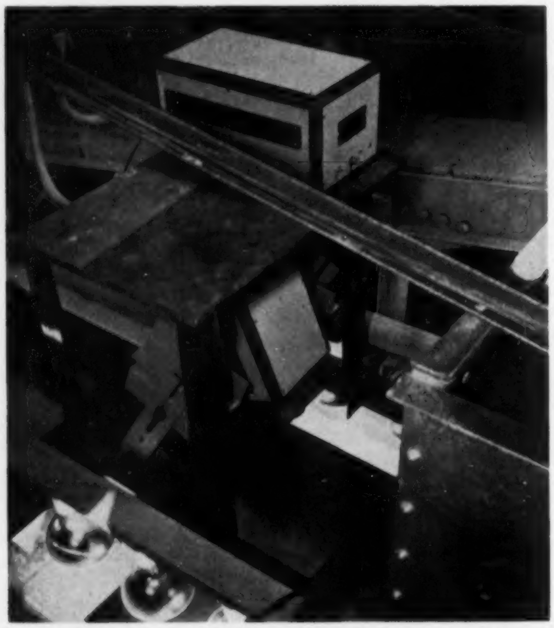


Fig. 5—Camera views area underneath tripper, providing picture of limestone level in bin to remote control operator.

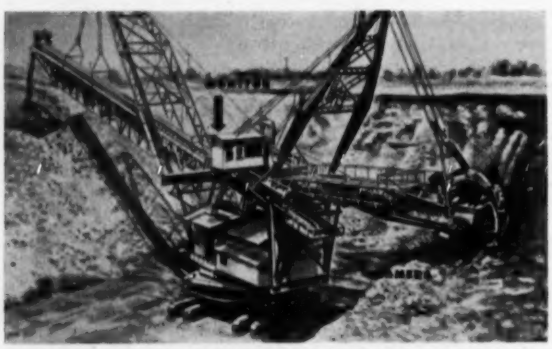


Fig. 6—Television camera mounted near scoop of earth remover provides close-up view of digging operation to operator in cab. Armored housing is removed to show camera.

designed to meet rigid requirements. Weatherproof housings protect cameras in outdoor locations and include several interesting design features to meet unique requirements.

Protection against wide variations in temperature is provided automatically by thermostatic actuation of a blower or heating element whenever pre-set ambient temperature limits are exceeded. Providing optimum visibility under adverse conditions requires inclusion of additional accessories originally designed for the automotive industry. A defroster for the observation window, remotely controlled, works in conjunction with a truck-type electric windshield wiper, also controlled from the viewing position, to permit observation under conditions of rain, snow, or sleet.

In some instances one camera can do the work of two by utilizing a turret containing several types of lenses that can be switched and focused from the monitor position. Camera accessibility and the relative need for observing two or more points simultaneously will determine the justification for such arrangements. Remotely controlled camera tilting and traversing supports increase its utility.

When use of ITV is under consideration, it is particularly important to determine exactly what must be seen by the camera. Simply to decide that the camera should view a belt conveyor, for instance, is insufficient. The key to obtaining desired results might depend on determining the presence or absence of material on the conveyor, amount or rate of spillage at a transfer point, size of material particles, or changes in the appearance of the material, to cite a few possibilities. Once the viewing requirement has been determined, camera location should be considered. In some instances the most obvious locations cannot be used because of interfering structures, or conversely because no structure is available on which the camera can be supported conveniently. Final choice of camera location dictates the type of lens required and often the need for accessory equipment. As the position of the camera varies so does its accessibility, ease of installation and, to some degree, the conditions under which it operates, all important considerations for the supplier who is suggesting the type of equipment and accessories for optimum performance.

Some viewing requirements which seem easy to the human eye may be difficult for the TV camera and vice versa. While the eye is more sensitive than the camera tubes used in ITV equipment and can see much greater detail normally, the camera lens may take in wide areas at a single glance, whereas the eye must scan them. One type of tube is sensitive in the infra-red and therefore sometimes obtains a more informative picture of incandescent bodies than is possible for the human eye. Fig. 8 shows the spectral response curves for Vidicon and image dissector as compared to the human eye.

Maintenance of closed-circuit TV equipment of the kind illustrated consists mainly of cleaning the lens and camera tube surfaces. Frequency of cleaning will be governed by conditions under which the camera must operate, but a definite schedule should be maintained, probably on a weekly basis under average conditions. Dust accumulation in other parts should be removed once a month, although this equipment has withstood prolonged neglect.

The 15 auxiliary tubes should be replaced at least every six months, not only when tubes fail, but on a definite schedule if application is critical. Since the

Fig. 7—The image dissector camera tube, heart of the Utiliscope ITV system. Internal parts of the tube are shown to left and right.

combined worth of auxiliary tubes, at list prices, is less than $45.00, their replacement after 4500 hr of service represents an insignificant hourly operational cost. All are commercially obtainable, as is the picture tube in the monitor which has a life expectancy of about one year and replacement cost of less than $35.00.

Camera tube replacement cost is a major consideration. Based on reasonable life expectancy (6 years) of the image dissector, priced at $1210.00,

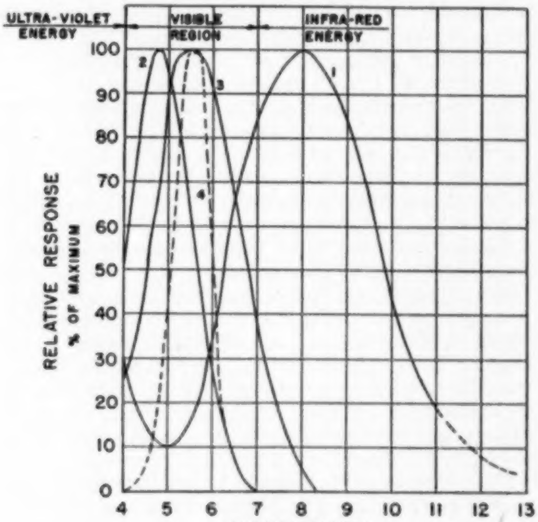


Fig. 8—Spectral response curves for image dissector and Vidicon camera tubes. Curve 1—image dissector, red sensitive; Curve 2—image dissector, blue sensitive; Curve 3—Vidicon, 6198; Curve 4—human eye.

this cost would be $200.00 yearly. Normally the dissector is guaranteed for one year, but it can be covered alternately by a two-year pro-rated use arrangement made possible by the record of service to date. Use of the Vidicon tube, also available with the type of equipment illustrated, will involve higher replacement cost, despite lower initial cost, because of much shorter life expectancy. It will be apparent that operational cost with either tube is nominal.

Because ITV equipment such as that illustrated is of straightforward design and requires no critical

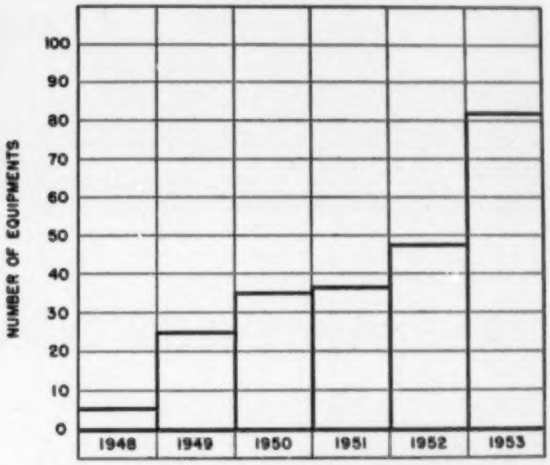
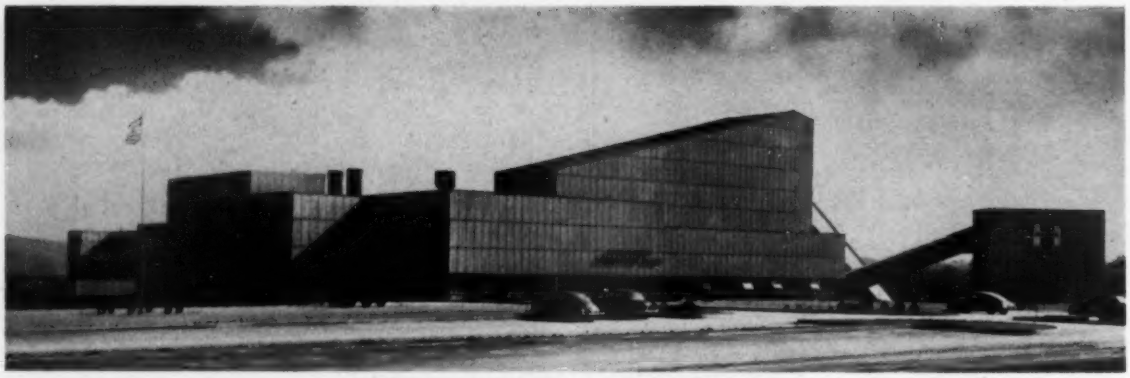


Fig. 9—Installations of ITV equipment. Yearly totals from 1948 to 1954.

alignment procedures for proper performance, service can be successfully accomplished by electrical maintenance personnel within an organization. It is essential, however, that such personnel understand the operation of the equipment. Sufficient time is allotted for this by the manufacturer's service representative when the equipment is adjusted initially. It is seldom that an organization having use for ITV equipment does not utilize sufficient instrumentation of other types to warrant the employment of electrical technicians.

The gradual growth of ITV during the past three years is indicated by Fig. 9, which shows the number of installations yearly from 1948 to 1954. In the average case at least six months elapsed between sale and installation, chiefly because many equipments were purchased for plants or facilities then under construction. The average elapsed operating time of all equipments, 95 pct of which were serving applications requiring continuous operation, was 2.2 years or 19,250 hr. Thus by 1954 ITV had provided more than 500 equipment-years of service to industry, a total indicating that it had progressed well past the point of experimental operation and become established as a means of instrumentation. Data is provided for only one manufacturer, as no other was active in this field throughout the period represented. Additional installations by other suppliers during part of this period were not sufficient to alter the trend significantly.

In view of its extraordinary commercial growth, which will continue unabated for at least a decade, it may be difficult at first to conceive that employment of TV for entertainment purposes could be outstripped by its expansion in closed-circuit usage, as has been predicted. However, it must be realized that its use as an entertainment medium has obscured appreciation of its fundamental purpose. Basically television is remote vision, as its definition implies, and while ITV is far from maturity, it has progressed sufficiently to warrant serious consideration as a medium of great industrial accomplishment.



The Georgetown preparation plant of Hanna Coal Co.

Oil Spraying at the Georgetown Preparation Plant

by A. F. Meger

Coal treatment by oil spraying receives special attention at the Georgetown plant for the dividends it pays in satisfying present customers and attracting new markets. Customer satisfaction requires care, quality control, and use of suitable oils.

REPRESENTED here are the ideas and varied experiences of many people in the Hanna Coal Co. who have helped develop, over a number of years, an efficient and flexible method for spraying controlled amounts of oil on coal. Since the Georgetown preparation plant began operations early in 1951, oil treatment of coal has received special attention. It is believed that oil treating will satisfy present customers and also attract new markets.

The first step in developing the new method of oil spraying was the construction of a dust cabinet for testing 50-lb samples of treated coal with the available oil sprays on the market. Tests results were tabulated for both indoor and outdoor storage.

The graph, Fig. 1, shows results of the original tests made with a 700-sec residual blend and a 500-sec lubricating oil on Georgetown stoker coal of 1¼x⅜-in. size.* The advantages of better price, smaller required amounts, and better storage characteristics originally credited to residuals have been refuted by results of later tests made with accurate metering equipment. Residuals still give the price advantage, but it has not been possible to arrive consistently at the other two benefits, so for all practical purposes residuals and pale oils are now classed together for required amounts and for effective storage time, see Fig. 2 and Table I.

* All information contained in this report deals only with the Pittsburgh No. 8 seam of bituminous coal.

The one major disadvantage of using residuals is the odor. Masking agents may help, but one load improperly blended can raise havoc. Some pale oils also, although odorless when delivered, give off a sweet sickening odor when atomized under pressure. It is recommended that all products be tested before they are used.

There is a specific place for all spraying oils. For example, at a power plant a severe dust condition exists around the stockpile area and in parts of the plant. The cheapest spraying oil made, regardless of odor, will do an excellent job in this case and will save the company 3 to 5¢ per gal or more. Domestic trade, on the other hand, must be carefully handled to prevent complaints about odor, and the only way to do this is to stay with the proved products after the odor tests have been made.

The preparation plant at Georgetown has facilities to handle either tank car or tank truck deliveries. Steam is available at the unloading point if the weather is severe, and there is an indicator at the unloading point to prevent overflowing the 20,000-gal underground storage tank. Systematic test samples are removed from each delivery and sent to the lubrication engineer to insure quality control.

Fig. 3 illustrates the chutes in which smaller sizes of coal are treated. Fig. 4 shows the entire spraying system. Buried in the ground is a 20,000-gal tank with immersion heaters grouped around the feeder line to insure adequate gravity flow to the pump under all conditions of weather.

Oil flows to a 500-gal preheating tank where the temperature is kept about 150°F by six 1½-kw immersion heaters thermostatically controlled. Hot oil is fed through a self-cleaning disc-type filter to the hydraulic pump. Valves and piping make it possible to transfer oil from one tank to another or to drain the lines for maintenance purposes. All this equipment is below ground level in a covered pump room,

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protected by CO_2 extinguishers and kept dry by an oversize sump pump.

The operating pressure, 750 to 1000 psi, is maintained at all times by a system of relief valves, solenoid valves, and time delay and pressure switches. As this entire plant is operated by only five control men, it was necessary to have a system as completely automatic as possible. A similar setup could be installed without the automatic devices, on as large or small a scale as desired.

Table I. Typical Screen Analysis of —3/8 Coal

Screen	Pct
3/8x1/4-in.	24.3
1/4x4-in.	17.2
+6	15.1
+8	10.2
+14	13.1
+24	7.5
+48	4.3
+100	2.9
+200	1.8
+325	1.1
—325	2.5

The operator controlling the five loading booms receives instructions to treat a specified number of cars. All he must do is push the start button and watch a gage until operating pressure is reached. The automatic circuit now takes over the controls. Oil starts through the lines, preheated when necessary by resistance heating, the 1-in. pipe being used as the heating element. All pipe is insulated both for heat and electrical conductivity. If the weather is extremely cold and oil is sluggish, the pressure will immediately jump to 1100 lb, the pressure setting of the safety relief valve. A pressure switch

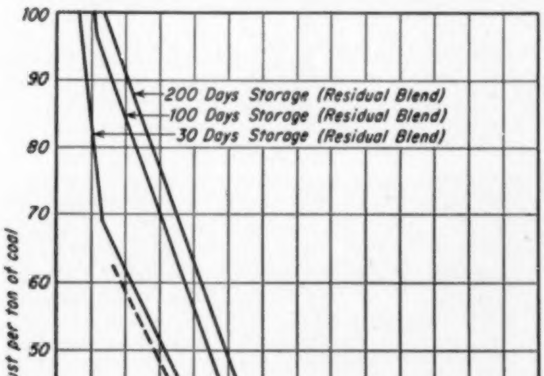


Fig. 1—Results of test made on 1¼x⅜-in. stoker coal with lubricating oils and residual blends. The average dust index for untreated 1¼x⅜-in. stoker coal is 215 g per ton of coal. The shaded area indicates where dust results are kept, including float dust.

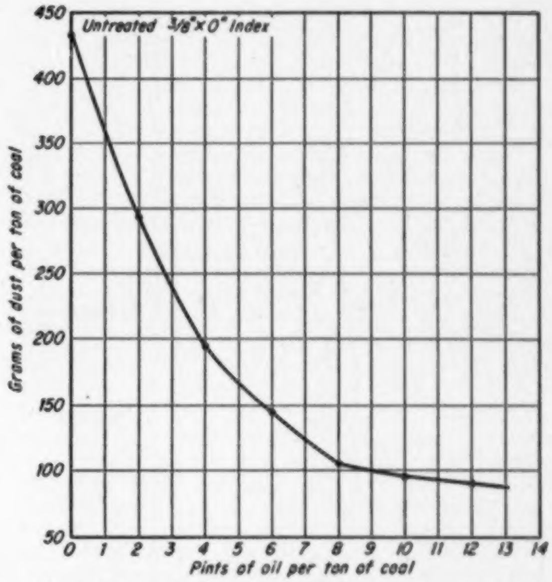


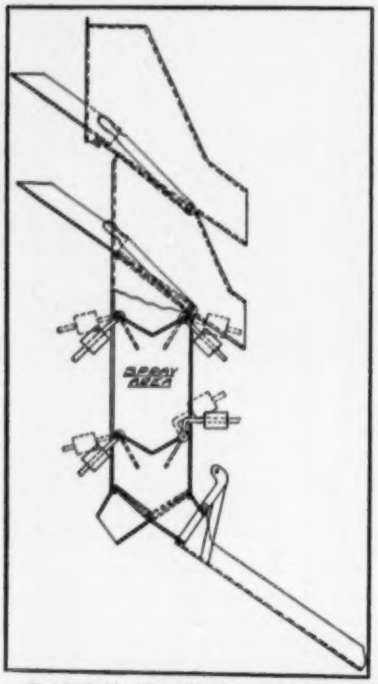
Fig. 2—Results of tests on —⅜ coal with seven oils ranging from low to high viscosity: 200 sec. pale lube oil; 1250 sec pale spray oil; 150 sec. pale spray oil; 800 sec. black spray oil; 500 sec. black spray oil; 800 sec. black spray oil; 200 sec. black spray oil. A typical screen analysis is shown in Table I.

will now activate a solenoid valve and timer, opening a through line for cold oil to return to the preheat tank and for 150° oil to fill the circuit for 20 sec. The timer then closes the solenoid valve and routes the oil through the proper relief valve directly to the pump. This relief valve is set at the operating pressure desired and helps keep the circulating oil constantly heated to approximately 100°F by friction alone. If for any reason the oil cannot take its normal path, the pressure switch will start the cycle over again. The fluctuating pressure gage and flickering panel lights warn the operator when trouble occurs. One to three cycles are usually required before the oil is ready to be sprayed at any one of the 10 stations.

In case of a line break with its attendant fire hazard and cleanup problem, a low-pressure switch has been installed to cut the pump motor when pressure drops below a predetermined setting. Panel lights and gage again warn the operator, who calls for a mechanic on the intercom.

High pressure meters with a flow indicator, as shown in Fig. 5, give the gallon per minute flow as the oil is being applied. Tonnage is estimated for the first car and checked and any necessary adjustments are made on the second car. Coal inspectors check meters and coal appearance at all times, recording amounts used. Solenoid valves control oil flow to any particular spraying point, but the gallon per minute flow is controlled by needle valves for each spray nozzle.

Coal sizes can be treated as follows: 1—The ⅜x0-in. coal is treated in the chamber shown in Fig. 3. 2—The 1¼x⅜-in. coal is treated in large chutes at the end of the loading boom, Fig. 3, or in a special chute carrying coal from the classifying shaker. 3—Any combination of 1½x0-in. can be handled in the large chutes shown in Fig. 3. 4—Egg sizes are handled at a transfer point on the rubber belt to prevent excessive breakage. 5—Lump coal is



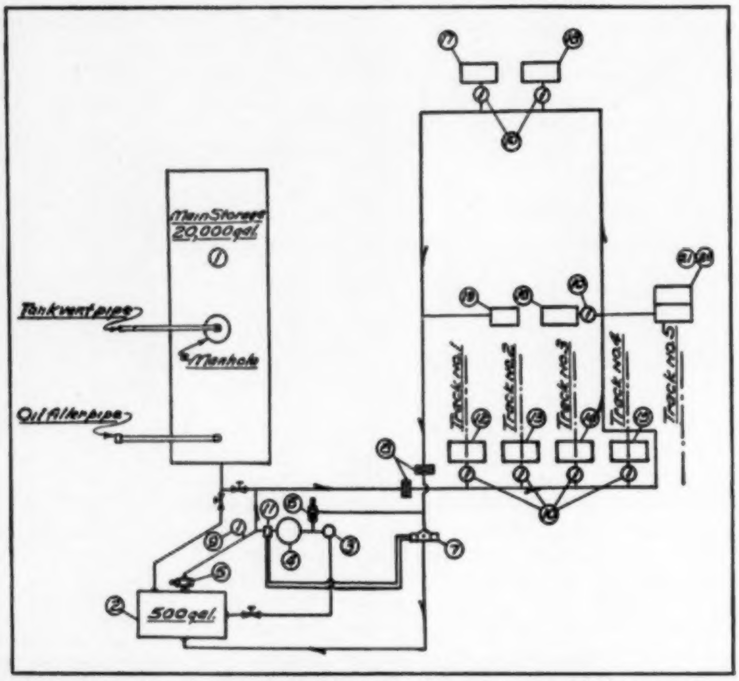


Fig. 3 (left)—The 1¼x⅜-in. coal is treated in large chutes, shown here, at the end of a loading boom, or in a special chute carrying the coal from the classifying shaker. Any combination of —1½ coal can be handled in the large chutes. Fig. 4 (right)—A diagram of the oil-treatment system at Georgetown preparation plant. Circled numbers indicate 1—the main storage tank; 2—the 500-gal heating tank; 3—the Cuno oil filter; 4—the Vickers pump (V-124), 17.5 gpm; 5—the Vickers relief valve (with spring No. 65705); 6—the Vickers relief valve (with spring No. 61470); 7—the Vickers solenoid valve; 8—insulating blocks; 9—Schraeder gage, which should read approximately 900 lb; 10—high pressure meters; 11—pressure switch; 12—spray chute, track No. 1; 13—spray chute, track No. 2; 14—spray chute, track No. 3; 15—spray chute, track No. 4; 16—egg spray, track No. 3; 17—the —⅜ slack spray chamber; 18—the 1¼x⅜-in. stoker spray chamber.

handled in an enclosed chamber over bar screens used to remove degradation and any excess oil in one operation.

To get the maximum results with a minimum of oil-fog settling out in the loading plant, the finer sizes of coal should be oil-treated by the method shown in Fig. 3. Coal is dropped through sealing flys into the spray chamber, which must be large enough to allow the coal bed to open up, exposing each individual piece to oil fog, no matter how

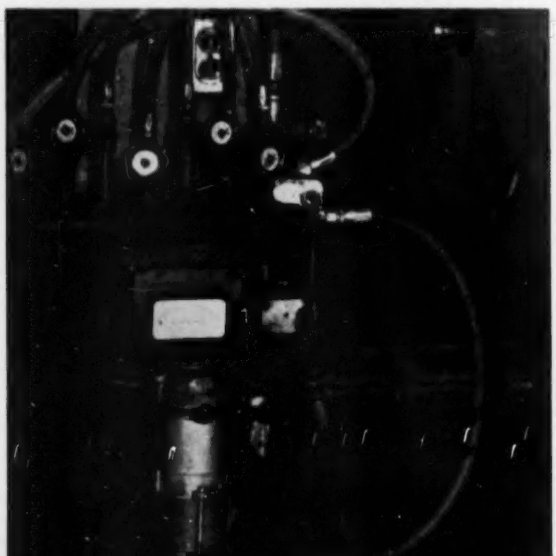


Fig. 5—High pressure meters with flow indicator give the gallon-per-minute flow.

Fig. 6—A view of one of the main treating chambers being used as a loading chute.

small. The lower flys seal off the bottom and spread the coal around to pick up any excess oil that may have gathered on the sides of the chute, preventing dripping into the cars. Excellent fogging or atomizing of the oil is achieved by the higher pressures and spraying nozzles used, insuring complete coverage. Laboratory dust checks for the proper amounts of oil to be used on the coal must take into consideration the handling and breakage of the coal until it reaches the consumer. At the Georgetown preparation plant it has been found that an increase of up to one pint will handle stoker coal for the most adverse conditions. Under ideal conditions oil cannot be seen on the coal, although the product is dust-free.

Fig. 6 is a view of one of the main treating chambers being used as a loading chute. It is completely automatic and hydraulically controlled to insure proper loading of cars to a maximum tonnage with a minimum of spillage. Operation of the back-loading or car-changing chute is very rapid and eliminates short shutdowns when car retarders stick, for coal can be backloaded until the car is rolling again. When a car is being loaded at a rate of 10 tons per min it is imperative that a rapid transfer arrangement be installed.

Tonnage capacity when coal is treated through the chambers is limited by coal size and type of treatment desired. At Georgetown 600 tph of 1½x0-in. coal have been treated, but above 300 tph the treatment proved to be very uneven.

Each spray chamber is equipped with sufficient nozzles to insure adequate oil for all tonnages handled. The best results seem to be with rates between 100 to 300 tph. In smaller chambers, tonnage can be dropped to a very low rate, but very small amounts should not be treated in chambers built for high tonnage, as oil fog will settle out on the side plates and drip down into the car. The area for spraying must be large enough to permit easy coal flow and yet small enough to prevent oil fog from gathering and dripping.

Pipe Resistance Method

It was originally thought that for proper treatment heavier oils were necessary, and resistance heating was incorporated so that any viscosity could be handled with equal success. It is now known that it is not necessary to go above 300-sec oil and so the heating system is a standby unit at present. If use of heavier oils were continued the following would hold true.

Constant temperature, as well as pressure, is important to insure an even flow of oil through the small orifices in fogging or spray nozzles. Forcing oil through a spool-type relief valve at 17½ gpm keeps the temperature about 100° to 120°F, depending on weather conditions. Auxiliary heat to raise this to 150°F or more is needed if the higher (1000+) viscosity oils are to be used successfully.

Welding machines of 300 amp can be used as the heat source. Special electrical insulators were designed for the 1-in. line to hold the high pressures and still be flexible enough to seal after alternate heating and cooling with accompanying expansion and contraction. Wherever a hydraulic hose was inserted, a jumper of copper wire was installed to maintain the circuit without the danger of overheating caused by a poor connection within the hose. Line resistance does not actually heat the oil passing through the circuit; it heats the conductor, which in turn keeps the oil next to the pipe in a fluid condition during extremely cold weather. Resistance heating keeps stationary oil in a fluid state and offsets heat loss due to radiation in a circulating system. In actual practice oil of 800 to 1000 viscosity has been forced through cold lines without trouble because of the precautions and valving arrangements. It is recommended that for greater viscosity additional heating facilities such as the pipe resistance method be used to insure movement of oil in the circuit under adverse weather conditions.

Tests have proved that a light, pale, odorless oil best satisfies customer demands for the particular coal treated at Georgetown. The spraying system is flexible enough to handle almost any oil, making it possible for the company to take advantage of price drops in distress oils, when the product is compatible with stocks on hand. In the past two years, various oils have been sprayed at Georgetown, ranging from residuals to lubricating stocks and varying in viscosity from 200 to 2000 at 100°F.

The following results have been taken from reports of coal shipments for the lake trade, where coal is handled in great amounts under all weather conditions.

1—The product is dust free. 2—Less moisture is absorbed when cars are caught in bad weather, and faster dewatering is possible. It follows that 3—coal is easier to move in cold weather, and when coal is frozen, the oil film prevents particles of coal from freezing solidly to the steel cars or to each other. To carry this advantage further, spraying equipment is being installed to treat empty railroad car sides and slopes prior to loading. 4—Treated coal moves more easily in cars, in stockpiles, or on conveying equipment.

The task of treating coal properly is by no means a hit-and-miss proposition. Suitable oils and methods must be used and should be made foolproof by constant quality control checks of the oil when it is delivered and the coal as it is loaded. There are no shortcuts to proper treatment.

Corrections

In the November 1953 issue: TP 3556A. The Status of Testing Strength of Rocks. By Rudolph G. Wuerker. P. 1113, Acknowledgments, should read as follows: This work is part of a comprehensive program of investigating strength properties of rocks undertaken by the Department of Mining and Metallurgical Engineering at the University of Illinois. The wholehearted support given the project by Professor H. L. Walker, Head of the Department, is herewith gratefully acknowledged. The tests performed at the University were made in the Department of Theoretical and Applied Mechanics.

In the December 1953 issue: TP 3642L. The Scintillation Counter in the Search for Oil. By R. W. Pringle, K. I. Roulston, G. M. Brownell, and H. T. F. Lundberg. P. 1257, captions for Figs. 3 and 4 should be transposed to read as follows: Fig. 3—Resolution energy relationship. Fig. 4—Th gamma ray scintillation spectrum. In the list of authors, p. 1255, G. M. Brownell's name should read as given here.

Tumbling Mill Capacity and Power Consumption as Related to Mill Speed

by R. T. Hukki

THE accepted basis of comparisons between mills of different diameter is the percentage critical speed.

If n = actual mill speed, rpm,
n_c = calculated critical speed, rpm,
n_p = calculated percentage critical speed, and
D = inside diameter of the mill in feet,

$$\text{then } n_c = 76.63 \frac{1}{\sqrt{D}} \text{ rpm} \qquad [1]$$

$$n_p = \frac{n}{n_c} 100 \text{ pct} \qquad [2]$$

$$n = 0.7663\, n_p \frac{1}{\sqrt{D}} \text{ rpm.} \qquad [3]$$

In the following analysis capacity, T, is expressed in short tons per hour, tph, and power consumption, P, in kilowatts, kw. Accordingly power consumption per unit of capacity, P_u, will be expressed in kilowatt hours per short ton, or kw-hr per ton. In all equations D refers to the inside diameter of the mill in feet and v to the peripheral speed of the mill in feet per minute inside the liners. Comparison between separate mills must be based on equivalent grinding conditions, i.e., same feed, same size distribution of feed, same size distribution of product, and same percentage of solids. In addition, comparisons between separate rod mills must be based on the same rods, same type of liners, and same percentage rod load. Comparisons between separate ball mills presuppose the same balls, similar liners, and same relative ball load. The practical n_p-range through which the equations apply varies, being narrower for fine grinding in ball mills and wider for coarse crushing in rod mills.

The Relationship between Capacity and Speed

It is the general belief that the capacity, T, of a tumbling mill is directly proportional to the speed of the mill, other things remaining constant.[1] Mathematically this is represented by the equation

$$T = c_1 n \text{ tph} \qquad [4]$$

where c_1 is a factor related with the grinding characteristics of the ore, method of reduction, and the units chosen.

It is proposed here that the general equation relating mill capacity and speed should be of the form

$$T = c_1 n^m \text{ tph} \qquad [5]$$

In other words, the capacity should be proportional to the mill speed raised to power m, the numerical value of the exponent being $1 \leqq m \leqq 1.5$, depending on the circumstances. Eq. 5 can also be written in the following forms:

$$T = c_2\, (n_p)^m \text{ tph, and} \qquad [6]$$

$$T = c_3\, v^m \text{ tph,} \qquad [7]$$

where v = peripheral speed of the mill in feet per minute.

If the observed capacity of a mill at speed n_1 is = T_1 tph, the capacity T_2 of the same mill at speed n_2 should be

$$T_2 = T_1\, (n_2/n_1)^m \text{ tph} \qquad [8]$$

The Relationship between Power Consumption, Mill Diameter, and Speed

The only well known theoretical deduction relating power consumption, P, and mill diameter appears to be the formula of duPont introduced by Gow, Guggenheim, Campbell, and Coghill.[2] According to duPont, the power required to operate a mill is a function of the mass of the balls, of the lever arm of the ball mass, and of the speed of the mill. The ball mass per unit of mill length is proportional to the square of the diameter, the lever arm is directly proportional to the diameter, and the critical mill speed or any percentage thereof is inversely proportional to the square root of the mill diameter. Following this reasoning, the original duPont formula is of the form

$$P = c_4 D^2 \cdot c_5 D \cdot c_6 D^{-0.5} = c_7 D^{2.5} \qquad [9]$$

If the mill speed in the above equation is expressed in terms of Eq. 3, the duPont formula may be written as follows:

$$P = f_1(D^2) \cdot f_2(D) \cdot f_3\left(\frac{n_p}{\sqrt{D}}\right), \text{ or} \qquad [10]$$

$$P = c_8\, n_p\, D^{2.5} \text{ kw} \qquad [11]$$

Eq. 11 may also be derived from the mechanical principle of force, which is equal to mass × acceleration. Power necessary to operate a mill may be considered to be an homogeneous linear function of the force developed. Ball or rod mass per unit of mill length is a function of D^2. The acceleration factor of the ball or rod mass is a function of the peripheral speed of the mill. Thus

$$P = f_4(F) = f_1(D^2) \cdot f_5(v).$$

Indicating that $v = \pi D n$, and $n = c_9\, n_p/\sqrt{D}$, the above equation becomes $P = f_1(D^2) \cdot f_5(\pi D\, c_9\, n_p/\sqrt{D}) = c_8\, n_p\, D^{2.5}$.

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Power consumption according to Eq. 11 must be considered as a first approximation only because the formula does not take into account the effect of mechanical losses such as friction in the bearings and gears.

The Relationship between Capacity, Mill Diameter, and Speed

As a first approximation, the capacity, T, of a mill may be considered as a function of the force acting inside the mill. Therefore

$$T = f_6(F) = f_1(D^2) \cdot f_7(v) \text{ tph} \qquad [12]$$

It was proposed earlier that capacity of a mill should be proportional to the peripheral speed raised to power m (Eq. 7). Correspondingly, the corrected formula for capacity should be of the following form

$$T = f_1(D^2) \cdot f_7(v^m) \text{ tph} \qquad [13]$$

Indicating again that $v = \pi D n$, and
$n = c_9 n_p / \sqrt{D}$, Eq. 13 becomes

$$T = c_{10} (n_p)^m D^{(2+m/2)} \text{ tph} \qquad [14]$$

which is the proposed basic equation relating capacity, mill diameter, and speed. If $m = 1.0$, Eq. 14 becomes

$$T = c_{10}\, n_p\, D^{2.5} \qquad [15]$$

If $m = 1.5$, it becomes

$$T = c_{10} (n_p)^{1.5} D^{2.75} \qquad [16]$$

The Relationship between Power Consumption per Ton, Mill Diameter, and Speed

The power (P_e) required for reduction of a unit weight of rock is equal to the total power consumed (Eq. 11) divided by the total tonnage handled (Eq. 14).

$$P_e = P/T = \frac{c_9\, n_p\, D^{2.5}}{c_{10} (n_p)^m D^{(2+m/2)}} \text{ kw-hr per ton}$$

from which

$$P_e = c_{11} (n_p)^{(1-m)} D^{(0.5-m/2)} \text{ kw-hr per ton} \qquad [17]$$

It can be seen from Eq. 17 that for $m = 1.0$, P_e is independent of the mill diameter and mill speed. Should m be > 1.0, the value of P_e decreases with increasing values of D and n_p. Should the value of $m = 1.5$, P_e decreases in proportion to $1/\sqrt{n_p}$, if the mill diameter remains constant, and P_e decreases in proportion to $1/\sqrt[4]{D}$, if the percentage critical speed of the mills under comparison remains the same.

Again, Eq. 17 gives a first approximation only. If the power drawn by the motor is the measured quantity as is the usual case, it will be consumed by mechanical losses, heat developed, and useful reduction work done. Eq. 17 will be correct only upon the condition that proportional distribution of energy between the three major components remains constant.

Discussion

The cornerstone of the mathematical treatment presented is the relationship between mill capacity and speed as expressed in Eq. 5. To prove it, the writer can introduce only one series of experimental evidence. This series is the result of the outstanding rod mill test performed by Banks in the Sullivan concentrator.[8] Respective numerical data are given in Table I. As will be seen from Fig. 1, the data give a straight line on logarithmic paper for the n_p-range of 50 to 85 pct. The slope m of the line is very close to 1.5.

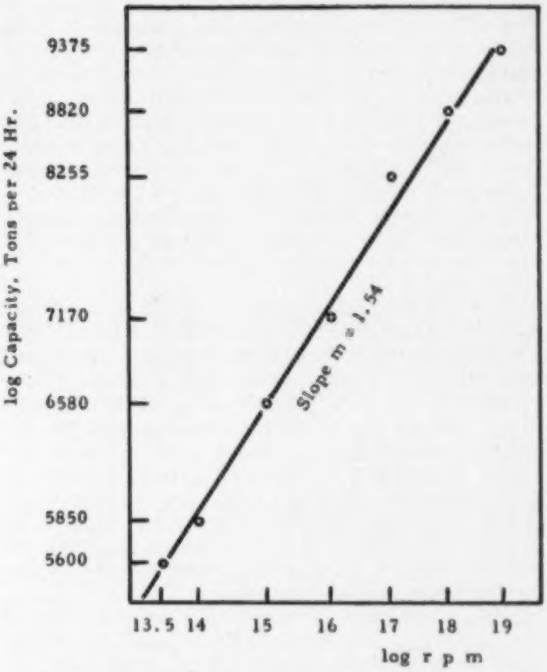

Fig. 1—Graphical presentation on a logarithmic paper of the results of the rod mill test by Banks.

Table I. Rod Mill Data by Banks

Speed, rpm	13.5	14	15	16	17	18	19
Tons per 24 hr	5600	5850	6580	7170	8255	8820	9375

The Sullivan rod mill with its fluid drive coupling has made this test possible, a test out of the reach of practically all other grinding installations. This may be why the relationship between mill capacity and speed has not been studied earlier in more detail and why the knowledge of this relationship has been based until now on crude observations.

The result of the Sullivan test, although startling, seems to have sound fundamental reasons. Considering the principle of force = mass × acceleration, the acceleration factor of falling rods increases more rapidly than peripheral speed with increasing mill speed. The application of greater force at higher speed will increase the probability of effective reduction, especially of the coarser fraction of feed.

The situation demonstrated in the Sullivan concentrator can undoubtedly be duplicated in other coarse-crushing rod mills. The slope of the line may or may not be equally steep in controlling rod mills, using the terminology introduced by Myers.[4] Slopes greater than 1.0 should be anticipated for ball mills grinding coarse ore. At present it is difficult to find evidence whether or not the numerical value of the slope would diminish toward 1.0 with ball mills grinding successively finer and finer feeds.

Extensive investigations have been undertaken to study the relationship between the power and capacity and the mill diameter of ball mills. As a result, both power and capacity have been expressed

as a function of mill diameter D raised to power p. The numerical value of exponent p was found to be 2.6 by Gow, Campbell, and Coghill,[5] 2.65 by Fahrenwald and Reck[6] for laboratory mills, 2.6 by the Lake Shore staff[7] for commercial ball mills, and for the capacity a variable figure from 2.5 for fine grinding in low-speed mills to 3.0 for coarse grinding in high-speed mills by Bond.[1] It should be emphasized that in none of these evaluations has the parameter of mill speed been included in the formula, although Bond seems to appreciate its effect by giving different values of the exponent p for mills of low and high speed.

The equations introduced in this paper seem reasonable in the light of the evidence cited above. The proposed equation, Eq. 14, for mill capacity agrees well with Bond's principle of varying exponent. Unfortunately the writer has not been able to find published data to check his equations against the respective relationships by Bond, who writes as follows:[1] "It is generally, but not universally, held that large-diameter mills have a higher mechanical efficiency than small mills or, in other words, that the capacity increases at a higher exponent of the diameter than 2.5, resulting in lower kwh/ton value for the larger mills."

Eqs. 11, 14, and 17 satisfy the requirements of this statement and seem to be in good agreement with the present-day trend toward very large diameter mills in grinding.

On the basis of the equations developed the following relationships should exist:

1—If the speed of a coarse-crushing rod mill is increased from n_p-value of 50 pct to n_p-value of 80 pct, its capacity will be doubled.

2—If the mill diameter is doubled and n_p remains constant, the increase of the mill capacity is 5.6 or 6.7-fold, depending on the value of the exponent of D ($p = 2.5$ or 2.75, respectively).

3—If the diameter of a coarse-crushing rod mill is doubled and the n_p-value increased at the same time as indicated in point 1, its capacity will be 13.4 times the original.

4—If the liner wear of a 6-in. mill is 2 in., the mill diameter will be increased by wear from 6 in. up to 6 ft 4 in. The effect of the increasing diameter on mill capacity will be 14.4 or 16.0 pct, depending on the exponent of D. At the same time, while the revolution per minute value of the mill remains constant, the n_p-value increases 2.8 pct. The minimum value of the final capacity will therefore be $= (102.8/100) \times 114.4 = 117.6$ pct and the maximum value $= (102.8/100)^{1.5} \times 116.0 = 120.9$ pct of the original, or the increase of the capacity 17.6 and 20.9 pct, respectively.

5—If the diameter of a coarse-crushing rod mill is doubled and the n_p-value remains constant, the power consumption per ton should decrease 15.9 pct.

The analysis presented above deals with the fundamentals of grinding. It is not possible for the writer to prove or disprove by experiment. Therefore the paper is presented as an invitation for discussion to the mill men in general. Their judgment, whatever it may be, would advance the present knowledge of the science of grinding.

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Activation Energies for the Decomposition Of Limestone, Dolomitic Limestone, and Dolomite

by J. H. Wernick

IN a study of the rate of decomposition of ½-in. cubes of limestone, dolomitic limestone, and dolomite in a sweeping nitrogen atmosphere, Joseph, Beatty, and Bitsianes[1] found that the zone of calcination advanced at substantially a constant rate at a given temperature. The purpose of this paper is to show that their data indicate at least two processes occurring when the above carbonates decompose. It is suggested that there are two processes occurring consecutively, one the limiting process in a given temperature range and the other the limiting process over another temperature range.

The data of Joseph and co-workers have been extended by use of the Arrhenius equation, Eq. 1, a relation beween the velocity constant k of a reaction and the absolute temperature T.

$$\frac{d \ln k}{dT} = \frac{A}{RT^2} \qquad [1]$$

A is the activation energy in calories per mol (additional energy that must be added for an average molecule to react), and R is equal to 1.986 cal

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Discussion on this paper, TP 3834H, may be sent (2 copies) to AIME before Sept. 30, 1954. Manuscript, Oct. 6, 1953.

per mol per degree. The integrated form of this equation is

$$\ln k = -\frac{A}{RT^{\circ}} + C \qquad [2]$$

where C is the constant of integration. This is the equation of a straight line. If $\ln k$ is plotted against $\frac{1}{T}$, the slope of the line is equal to $-\frac{A}{R}$ and the activation energy, A, can be calculated.

The specific rate data measured by these workers are plotted against $\frac{1}{T}$ in Fig. 1. The full circles are the experimentally determined points and the open circles are points taken from the curves drawn through their experimental points. The open circles were used to determine more closely the slopes of the high and low temperature portions of the smooth curves. The plots show a gradual change in the slopes of the low-temperature portion of the curves as the temperature is increased, indicating a change in the limiting process. This writer's activation energies A_1 and A_2, corresponding to the low and high-temperature portion of the curves respectively, are given in Table I.

At low temperatures the reaction having the larger A value (A_1) is the observed rate-controlling process, and at the high temperatures the reaction having the smaller A value (A_2) dominates. The A_1 values are of the same order of magnitude as the heat of dissociation of $CaCO_3$ at 800°C, namely 40,000 cal per mol, and it appears that activation energy for the reverse process will be small, so the state consisting of CaO and free CO_2 gas lies close to the state corresponding to the crest of the energy barrier (state of the activated complex). This quantitatively accounts for the observation that CaO picks up CO_2 readily from the atmosphere. It is interesting to note that the A_1 values are of the same order of magnitude as the resonance energy (42,000 cal per mol) for the carbonate ions in the dialkyl carbonates for resonance of the double bond among three positions.[3] The resonance energy is the additional stabilizing energy of the carbonate ion, and at least this amount of energy must be added to an average molecule before decomposition can occur.

Table I. Activation Energies for the Decomposition of Dolomite, Dolomitic Limestone, and High Calcium Limestone

Item	A_1 (Cal Per Mol)	A_2 (Cal Per Mol)
Dolomite	43,250	19,620
Dolomitic limestone	46,000	19,900
High calcium limestone	46,000	25,800

The region of temperature where there is a gradual change in the slope of the low temperature portion of the curves as the temperature increases can be attributed to a situation where both processes are occurring at comparable rates and neither predominates. As a result of this the observed rate at a given temperature within this temperature region will be determined by the rate at which both processes occur. In other words, the differential equation expressing the rate process at a given temperature will contain the specific rate constants of both consecutive processes occurring, and none can be neglected. In this temperature region, the effect of

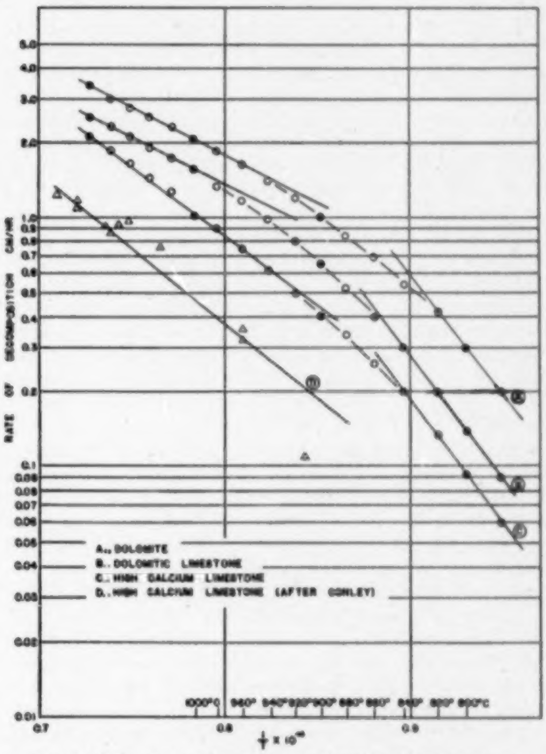

Fig. 1—Rate of decomposition as a function of temperature.

temperature will be complex, since both processes will have different temperature coefficients. At sufficiently low temperatures or at sufficiently high temperatures, where one of the two processes occurs so slowly in comparison to the other, the observed rate is determined essentially by the slowest process and the observed temperature effect will be given by the Arrhenius equation.

The justification for splitting the curves of Joseph et al into two straight lines, even though there are only four experimental points, is derived from other experimental work. For example, Bischoff[9] studied the decomposition rate of dolomite and limestone in various atmospheres in the temperature range 550° to 800°C. For dolomite, he found the A values to be 44,238 cal per mol for dry air, 40,939 cal per mol for moist air, and 26,670 cal per mol for steam. For limestone, in dry air and steam, he calculated A values of 47,664 and 38,972 cal per mol respectively. The reactivity of carbonates is greatly influenced by water vapor.[4] These A values substantiate the A_1 values of Joseph and co-workers if the steam data are excluded. Conley[5] determined the rate of decomposition of a high calcium limestone at temperatures above 916°C under one atmosphere of CO_2 (equilibrium decomposition temperature approximately 900°C.) His data are plotted also on Fig. 1, line D. The line drawn through the experimental points has the same absolute slope as the line drawn by Conley. From his rate data, this writer has computed an activation energy of 27,000 cal per mol, in agreement with the A_2 value of Joseph and coworkers for the same material. The high activation energy, A_1, at the lower temperatures, may be due to the probably difficult process of removing CO_2 molecules from the $CO_3^{=}$ ions in the hexagonal lattices of calcite and dolomite. The moment decomposition

starts in $CaCO_3$, for example, Ca^{++} ions and the remaining $O^{=}$ ions must, by diffusion, form the cubic CaO lattice. It is not until the higher temperatures are reached that this latter diffusion process becomes sufficiently dominant, giving rise to a lower activation energy. Barrer[6] points out that the activation energy for diffusion in ionic crystals is smaller than the activation energy for diffusion in metals and that this is due to the lower densities of salts and the greater effect of polarization forces. However, this comparison is based on data for diffusion in ionic crystals where the cation or anion or both are univalent. Actually data for diffusion in bivalent ionic crystals of the RX type are insufficient to permit positive naming of the diffusion process as the limiting one at the elevated temperatures. For the reverse process (combination of CaO with CO_2) diffusion of Ca^{++} and $O^{=}$ ions will be the limiting process at the lower temperatures.

The effect of water vapor in increasing the rate of decomposition of limestone and dolomite (lowering of the activation energy) mentioned above can possibly be explained on the basis of the dipole nature of a water molecule[2] (unsymmetrical charged entity for practical purposes.) Conceivably the dipoles can interact with the bonding situation at the reacting interface to weaken the structure and permit CO_2 to escape more readily. Such types of interactions might also be used to explain some of the other results of Bischoff[7] and the fact that H_2 readily reacts with limestone at 600°C.[8] In the latter case, H_2 enters into chemical combination with the CO_2 to produce CO and H_2O.

The rate data of Ralston, Pike, and Duschak[9] for the decomposition of magnesite under one atmosphere of CO_2 in the temperature range of 600° to 850°C indicate that a change in the controlling reaction takes place at about 675°C. If the logarithm of the time for 50 pct decomposition is taken from their data and plotted against $1/T$, the A_1 values vary between 24,400 and 32,000 cal per mol, and the A_2 values are about 17,000 cal per mol. Their low temperature data, however, are meager and the A_1 values were calculated on the basis of only two points. From heat of formation data at 20°C and heat capacity data, the heat of decomposition of $MgCO_3$ was calculated to be about 25,100 cal per mol at 627°C and is of the same order of magnitude as the above A_1 values. Bischoff[7] determined an activation energy of 36,128 cal per mol for decomposition of $MgCO_3$ in vacuo in the temperature range 400° to 600°C. The smaller A_1 value for magnesite compared to calcite may be attributed to a greater polarizing effect by the $CO_3^{=}$ ion on the smaller Mg^{++} ion and consequently, a stronger bond between the Mg^{++} and $CO_3^{=}$. As a result of this, the $CO_3^{=}$ ion would be weaker in so far as removal of CO_2 is concerned. The smaller Mg^{++} ion (radius of 0.72A)* might also account for the lower A_2 values of Ralston and co-workers for magnesite. The idea of the greater ease with which the smaller ion may diffuse, giving rise to a smaller activation energy, is supported by the lower A_2 values derived from the data of Joseph and co-workers for the dolomite and dolomitic limestone.

* Average of values of Pauling and Goldschmidt.[3]

Spencer and Topley[4] studied the rate of decomposition of chemically prepared crystalline Ag_2CO_3 in vacuo in the temperature range 147° to 225°C, and for three different preparations, A, B, and C, they calculated activation energy values equal to 23,400, 22,800, and 22,500 cal per mol respectively. They showed that the ratio of the linear rate of propagation of the reaction to the initial radius of the particles was substantially a constant during the course of the reaction at constant temperature. The heat of dissociation of Ag_2CO_3 at 20°C, calculated from heat of formation data, is about 19,550 cal per mol. Because of the lack of sufficient heat capacity data, the heat of the reaction at higher temperatures cannot be calculated, but it will be somewhat less at the temperatures at which Spencer and Topley worked. Presumably this range of temperatures corresponds to activation energy values which may be labeled as A_1, and for this carbonate also the final state lies close to the state corresponding to the crest of the energy barrier.

Conclusions

It appears that there is a change in the rate-controlling process for the decomposition of limestone, dolomitic limestone, and dolomite as the temperature is raised. It is suggested that the breakup of the carbonate ion is the limiting process at temperatures below about 880°C, the diffusion of the cations and $O^{=}$ ions being the rate-determining process above this temperature.

It is believed that since the various carbonate compounds encountered in nature decompose readily at different temperatures, a fruitful line of reasoning and experimentation to explain this fact can be based on fundamental differences of compounds.

It is clear that the atmosphere in which the carbonates are decomposing can influence decomposition rate. It is suggested in this paper that this effect might be attributed to fundamental interactions between the bonding situation at the surface of carbonates and molecules of the gaseous atmosphere.

Acknowledgment

The writer wishes to thank H. M. Davis, R. W. Lindsay, J. W. Fredrickson, A. J. Shaler, and the other members of the staff of the Division of Metallurgy, The Pennsylvania State University, for their helpful discussions during the preparation of this paper.

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Mining Branch Nominations for 1955

This is the complete list of officers nominated for the Mining Branch and its Divisions. Nominations of AIME officers for 1955 appear on page 736.

Minerals Beneficiation Div.

Chairman, Will Mitchell, Jr., Allis-Chalmers Mfg. Co.; Associate Chairman, Norman L. Weiss, American Smelting & Refining Co.; Regional Vice Chairmen, W. B. Stephenson, Allen-Sherman-Hoff Pump Co., and Nathaniel Arbiter, Columbia University; Secretary-Treasurer, Wayne L. Dowdey, Eimco Corp.

Mining, Geology, and Geophysics Div.

Division Chairman, E. L. Clark, Missouri Geological Survey; Mining Subdivision Chairman, Elmer A. Jones, St. Joseph Lead Co.; Geology Subdivision Chairman, Charles Meyer, University of California; Geophysics Subdivision Chairman, F. W. Hinrichs, Fairchild Aerial Surveys Inc.

Industrial Minerals Div.

Chairman, Sanford S. Cole, National Lead Co.; Eastern Vice Chairman, George W. Josephson, U. S. Bureau of Mines; Southeastern Vice Chairman, James A. Barr, Sr., consultant; Rocky Mountain Vice Chairman, John E. Allen, New Mexico Institute of Mining & Technology; Pacific-Northwest Vice Chairman, Howard A. Ziebell, Northwest Magnesite Co.; Canadian Vice Chairman, Charles D. Borror, Canadian Johns-Manville Co., Ltd.; Western Vice Chairman, R. H. Jahns, California Institute of Technology; Secretary-Treasurer, Charles M. Cooley, AIME Staff. Executive Committee: Raymond B. Ladoo, consultant; Thomas L. Kesler, Foote Mineral Co.; and John G. Broughton, New York State Science Service.

Minerals Economics Div.

Chairman, C. W. Merrill, U.S. Bureau of Mines; Vice Chairman, Franz R. Dykstra, E. J. Lavino & Co.; Vice Chairman, S. H. Williston, Cordero Mining Co.; Vice Chairman, R. M. Foose, Franklin & Marshall College; Secretary-Treasurer, R. A. McCormick. Executive Committee: E. W. Pehrson, U. S. Bureau of Mines; F. R. Milliken, Kennecott Copper Co.; G. C. Monture, Dept. of Mines & Technical Surveys, Ottawa; G. S. Borden, Standard Oil Co. of Calif.

Coal Div.

Chairman, H. F. Yancey, U. S. Bureau of Mines; Chairman-elect, Carl T. Hayden, Sahara Coal Co.; Secretary-Treasurer, David R. Mitchell, Pennsylvania State University. Executive Committee (1955-58): J. Allan Brookes, Mather Collieries; William W. Everett, Glen Alden Coal Co.; and Charles T. Holland, Virginia Polytechnic Institute.

Mining Branch Council

Chairman, R. C. Stephenson (Ind. Min. Div.), Woodward & Dickerson Inc.; Secretary, C. M. Cooley, AIME Staff. Members: M. D. Cooper (Coal), National Coal Assn.; J. D. Forrester (MGGD), Missouri School of Mines; S. D. Michaelson (MBD), Tennessee Coal & Iron Div., U. S. Steel Corp.; E. L. Clark (MGGD), Missouri Geological Survey; J. R. Van Pelt, Jr. (MIED), Montana School of Mines; Will Mitchell, Jr. (MBD), Allis-Chalmers Mfg. Co.; S. S. Cole (Ind. Min. Div.), National Lead Co.; C. W. Merrill (MED), U. S. Bureau of Mines; and H. F. Yancey (Coal), U. S. Bureau of Mines.

Mineral Industry Education Div.

Chairman: J. R. Van Pelt, Jr., Montana School of Mines; Vice Chairman, J. W. Stewart, University of Alabama; Secretary, O. C. Shepard, Stamford University. Executive Committee (three years): Charles Meyer, University of California; J. W. Vanderwilt, Colorado School of Mines; R. D. Parks, Massachusetts Institute of Technology.

Chicago Advertising Representative Named

Robert W. Wilson has been engaged to sell advertising space in MINING ENGINEERING and the JOURNAL OF METALS from headquarters in Chicago. He is a B.S. graduate in journalism from Northwestern, with special work in advertising and business management. For nearly three years he has been with Flexonics Corp., formerly Chicago Metal Hose Corp., Maywood, Ill., for the last two years as advertising manager. His Chicago headquarters will be in the offices of the Western Society of Engineers, 84 E. Randolph St., Chicago.

CIM Forms Hamilton Iron and Steel Branch

The Hamilton Iron and Steel Branch has been organized as a technical body aiming to serve the interests of the Canadian iron and steel industry. The Canadian Institute of Mining & Metallurgy, with its long established reputation as a professional body, serving essentially the mining industry, is being developed as the parent Institute. In Hamilton, as the center of this industry, the first branch of the CIM has been formed. It will devote itself entirely to the technical aspects of iron and steel production, fabrication, etc. Its function will be similar to the AIME Iron and Steel Div. in United States, and the Iron and Steel Institute in the United Kingdom. Through the Hamilton Branch, the CIM will identify itself more closely with iron and steel. The Institute's bulletin has been made available for the publication of technical articles.

Back Issues Requested

Institute headquarters will pay 50¢ for back issues of the following magazines received: MINING ENGINEERING; October 1953, November 1953, January 1954, February 1954. JOURNAL OF METALS; August 1953, March 1954, April 1954.

Technical Papers, Grid Contest Features of Salt Lake Meeting

The technical program of the Rocky Mountain Region Industrial Minerals Conference at Salt Lake City, October 28 to 30 promises to have something for everybody. Papers to be presented will cover much of the industrial minerals field from the economic, theoretical, and practical aspects.

The first session, scheduled for Friday, October 29, will have papers dealing with *Industrial Water*, by E. Nelson; *The Role of Industrial Minerals in Utah's Steel Industry*, by John K. Hayes; *Natural Gas in the Intermountain Area*, by H. F. Hillard, and *Chemical Treatment of Ores*, by C. A. Romano.

J. Bracken Lee, Governor of Utah, will speak at the Industrial Minerals Luncheon set for Friday afternoon.

After the luncheon a technical session covering titanium and open pit phosphate mining will be held. Other papers at the session will describe phosphorus production, discuss cement plant economics, and consider barite as an industrial mineral.

Saturday morning's technical session papers will encompass: *Uranium in the Colorado Plateau*, by Marvin L. Kay; *What About Gilsonite*, by Park L. Morse; and *Gypsum in Utah*, by W. S. Mole.

This is baseball weather, but the Utah Section is looking forward to the football game between the University of Utah and University of Idaho. Following the last technical session, busses will transport those wishing to attend the game to the University of Utah Stadium in Salt Lake City. The game should be one of the most outstanding grid contests of the 1954 season.

The Utah Section will hold its AIME Annual Fall Cocktail Party and Dinner Dance in the Grand Ballroom of the Newhouse Hotel, starting at 7 pm, Saturday. The Newhouse Hotel will be headquarters for the conference.

Salt Lake City's Newhouse Hotel will be headquarters for the Rocky Mountain Region Industrial Minerals Conference. Grand Ballroom of the hotel will be the scene of the Annual Fall Cocktail Party and Dinner Dance.

Outline Policy On Meeting Fees For 1954

For some years the registration fees charged nonmembers of the AIME at the Conferences of the Iron and Steel Div. have been deductible on the initiation fee charged the registrant if he subsequently applies for Institute membership. This practice will continue in 1954, and the Executive Committee has voted that the same privilege may be granted for the balance of the year to registrants at all Branch and Divisional meetings provided the fee to be credited is turned over to the Institute and not retained by the Branch or Division concerned.

AIME Volumes Issued

The following volumes published by the AIME have been issued in the first five months of the year and have been mailed to those who have ordered them. Others may purchase them as long as the stock lasts at the prices mentioned:

Transactions Vols. 196, Mining Branch (1953); No. 197, Metals Branch (1953); and No. 198, Petroleum Branch (1953). $7 less 30 pct to AIME members; foreign, $7.50.

Dislocations in Metals. $5, less 30 pct discount to AIME members.

Statistics of Oil and Gas Development and Production, Vol. 7 (data for 1952). $10, less 50 pct discount to AIME members.

Ore Deposits of the Western States (Lindgren volume reprint). $7 less 30 pct discount to AIME members.

Bequests to AIME

Occasionally the Secretary has been asked how bequests may be made to the Institute. Unless the donor has some special use for the money in mind it is desirable to avoid specifying limitations and allow the Board of Directors to decide in what way the principal or income can best be used. If a specific purpose is expressed in the behest it may develop that it is impractical to use the funds in the manner stated.

The following wording is suitable:

"I hereby bequeath to the American Institute of Mining and Metallurgical Engineers, Incorporated, a corporation organized under the Membership Corporations law of the State of New York, the sum of ——— to be used for the general purposes of the American Institute of Mining and Metallurgical Engineers at the discretion of its Board of Directors."

Annual Meetings For 1959 and 1961

The Board of Directors has accepted invitations from the San Francisco Section to be host for the Annual Meeting in 1959, and from the St. Louis Section for the meeting in 1961. The dates will be Feb. 15 to 19, 1959, and Feb. 19 to 23, 1961. Annual Meetings heretofore scheduled are: Chicago, Feb. 13 to 17, 1955; New York, Feb. 19 to 23, 1956; New Orleans, Feb. 24 to 28, 1957; New York, Feb. 16 to 20, 1958; New York, Feb. 14 to 18, 1960; and New York, Feb. 18 to 22, 1962.

Bring Sports Gear to Lake Placid Industrial Minerals Meeting

Lake Placid, scene of the Fall Meeting of the Industrial Minerals Div., October 5 to 9, ranks high as one of the sporting paradises of the nation. It offers everything from skiing on land and water, to mountain climbing, hiking, horseback riding, and fishing.

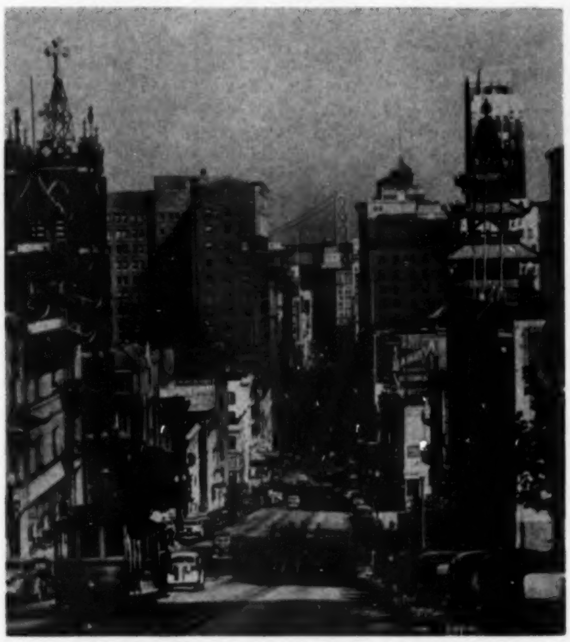
Streams and lakes of the area provide some of the best game fishing in the East, and its mountain beauty makes the perfect backdrop for just enjoying life. The Whiteface Inn, headquarters for the meeting, is one of the most noted hostelries in New York State. The Fall Meeting comes during what the natives call the "flaming leaves season," when nature's colors are as flamboyant as the most fantastically hued painting made by man.

The Adirondack Section, hosts for the Fall Meeting, are preparing what many consider to be one of the most interesting programs dealing with Industrial Minerals ever assembled. Invitations to participate in the meeting program as guests have been extended to the Mining Society of Nova Scotia, the Industrial Minerals Div. of the Canadian Institute of Mining & Metallurgy, and Society of Economic Geologists.

Hay fever sufferers can look forward to a peaceful time. The resort lies some 2000 ft above sea level. Other attractions include the Craig Wood Golf & Country Club, one of the outstanding courses in the country. Warm weather ice skating is another of the Lake Placid features. Needless to say, this is the place for color-loaded cameras.

Fishing at its best is one of the prime attractions of the Lake Placid area. Its streams and lakes abound with fighting game fish.

AIME Meetings Scheduled for San Francisco and Pittsburgh



San Francisco will be host to the Minerals Beneficiation Div. Fall Meeting, September 24. The division meeting follows the American Mining Congress convention. Cable cars still play an important part in climbing the city's famous hills.

AIME and ASME join once more on October 28 and 29 in the annual Fuels Conference. This year it will be held at Pittsburgh, whose Golden Triangle, shown above, is undergoing extensive redevelopment.

Petroleum Executive Heads 1955 AIME Nominations

For President

C. E. Reistle, Jr., member of the Board of Directors of Humble Oil & Refining Co. in charge of the pro-

C. E. REISTLE, JR.

duction dept., has been nominated for the Presidency of AIME in 1956. Born in 1901 in Denver, Colo., Mr. Reistle was graduated from the University of Oklahoma in 1922 with a B.S. degree in chemical engineering. He began his career in the oil industry by working as a roustabout for the Carter Oil Co. during summer vacations while attending college. Soon after his graduation Mr. Reistle joined the U. S. Bureau of Mines in Bartlesville, Okla., as a junior petroleum chemist. While with the Bureau he visited and worked in many of the major oil fields in the country. During this time he published a number of articles on oil field brines, paraffin problems in the production of crude oil, and the operation of flowing wells. In 1933 Mr. Reistle left the Bureau of Mines to become chairman of the East Texas Engineering Assn., a cooperative organization formed to obtain engineering facts on the efficient operation of the East Texas field. He was in charge of gathering these facts, with the aid of the companies operating in the field. His efforts played an important part in establishing efficient production rates and practices for the field. In August 1936 Mr. Reistle joined Humble Oil & Refining Co. as engineer-in-charge of the petroleum engineering div. and in 1940 was advanced to the head of the division. He remained chief petroleum engineer until February 1945, when he was made general superintendent of the production dept., and in August of the same year he became manager of production operations. Mr. Reistle was elected to the board of directors of the Humble Co. in 1948. During World War II he was technical advisor for District III of the Petroleum Administration for War. He was also national vice chairman of the Oil Industry Advisory Committee for OPA.

For Vice Presidents

Walter A. Dean, Cleveland Works chief metallurgist of the Aluminum Co. of America, has been nominated for Vice President and Director of AIME. Mr. Dean attended Cooper Union Institute of Technology in New York City and received his B.S. degree in chemical engineering from there in 1926. He continued his studies at Rensselaer Polytechnic Institute receiving his M.S. degree in 1927 and a Ph.D. in 1929. While there he was elected to Sigma XI. On graduating from Rensselaer he accepted employment at the research laboratories of the Aluminum Co. of America located at New Kensington, Pa. In 1931 he was transferred to the research laboratories at Cleveland where he remained until 1945. He was named assistant manager of the permanent mold plant at Cleveland in 1945 and in 1949 became the Cleveland Works chief metallurgist, the position he holds to this date. His work at the research laboratories was concerned largely with the development of alloys and processes. He has written articles on machineability of aluminum and is the author or co-author of approximately 90 patents covering alloy and process developments.

William W. Mein, Jr., who has been nominated as a Vice President and Director of AIME, is president of Calaveras Cement Co., Bishop Oil Co., and Clear Lake Water Co. all of San Francisco. Mr. Mein is a graduate of Harvard College, Class of 1932, with an A.B. degree in engineering sciences. Shortly after graduation he started with Calaveras Cement Co. as field and office engineer at the cement plant in San Andreas, Calif. Following this position, he spent two years as petroleum production engineer and oil geologist for Bishop Oil Co. at various oil field locations in Texas and Oklahoma. Resuming his employment with Calaveras Cement Co. in San Francisco, Mr. Mein progressed from office engineer to purchasing agent to assistant vice president to vice president. In April 1943 he was also elected vice president of Bishop Oil Co. In June 1947 he became president of Clear Lake Water Co. Mr. Mein was elected president of

W. A. DEAN

W. W. MEIN, JR.

Calaveras Cement Co. in April 1951 and president of Bishop Oil Co. in May 1953. From 1944 to 1945, he was appointed by Governor Earl Warren to the California State Mining Board and became its secretary. He has recently served on the National Minerals Advisory Council of the Dept. of the Interior and the Natural Resources Committee of the U. S. Chamber of Commerce. In order to devote more time to his family and work he recently resigned from the Woodside School Board after being elected to three terms. Besides his directorships in Calaveras and Bishop, he is also on the board of Commonwealth Investment Co. and Clear Lake Water Co.

Grover J. Holt, Chairman of the Nominating Committee, has announced nominations for President-Elect, Vice Presidents, and Directors for 1955. As provided in Art. IX, Sec. 2, of the bylaws, 25 Members or Associate Members may sign and transmit to the Secretary's office prior to Sept. 1 "any complete or partial ticket of nominees," should they wish other candidates to be considered.

In such instance, a letter ballot will be forwarded to all Members in good standing in the United States, Canada, and Mexico, tabulating both the official ballot and any supplementary nominations. If no supplementary nominations are thus received, no letter ballot will be printed, and nominees on the official ballot shall be declared duly elected at the meeting of the Board of Directors or the Executive Committee in November.

For Directors

Richard Whitsett French, Jr., vice president of production for the Standard Oil Co. (Ohio), has been nominated as a Director of AIME. Born in Colorado Springs, Colo., Mr. French attended the Universities of Delaware, Southern California, and Harvard. He began his career with the General Electric Co. While at GE he worked on marine and aeronautical engineering. Later Mr. French joined the U. S. Air Corps as a flying cadet. He served at Kelly Field as an armament officer and assistant engineering officer. He held the rank of second lieutenant when he was discharged. In 1933 he joined the Continental Co., Ventura, Calif. He worked his way up to field engineer and in 1936 was promoted to production engineer in the Los Angeles office. For the next seven years he directed all of Continental's petroleum and production engineering in California. In 1943 he was moved to Ponca City as assistant manager of the production dept. While here his work covered all phases of engineering and production as well as administrative duties. Mr. French remained with this firm until 1947, when he accepted a position with the Sohio Petroleum Co., as chief engineer and assistant to the vice president in charge of production. In 1948 he was named vice president. Mr. French was appointed vice president and general manager of the production dept. for Sohio in 1953. Since April 1954 he has been vice president of production for the Standard Oil Co. (Ohio).

D. C. Helms has been nominated Director of AIME. Mr. Helms has been associated with the Lehigh Navigation Coal Co. since 1909. Prior to that he had worked at the Brooklyn Navy Yard and American Bridge Co. For a short time he was associated with the St. Clair Coal Co. and Philadelphia & Reading Coal & Iron Co. His first position with Lehigh was as a chairman and draftsman. He became division engineer, assistant mining engineer, and stripping superintendent, respectively. In 1918 he was named superintendent of the Alliance Coal Mining Co. During the years 1918 to 1938 he was superintendent of several divisions for the firm. Mr. Helms was appointed mining engineer and cost supervisor for the company in 1938. From 1944 to 1947 he was production manager and was then appointed general manager. He was vice president for two years, prior to his retirement.


R. W. FRENCH, JR.


D. C. HELMS


A. J. HERZIG


H. C. PYLE

Alvin J. Herzig, recently elected vice president, research, Climax Molybdenum Co., has been nominated as a Director of AIME. Mr. Herzig was born at Toledo, Ohio, and graduated from the University of Michigan. In 1926 he was employed by the National Supply Co., Toledo, where specialization in physical metallurgy began. He returned to the University of Michigan to conduct research work on brass and work for an advanced degree. He received his M.S.E. in 1931. After receiving this degree he joined the staff of the Climax Molybdenum Co., as chief metallurgist. In 1943 Mr. Herzig was made vice president in charge of the laboratory. Mr. Herzig was elected to the presidency of Climax Molybdenum Co. of Michigan in 1949.

Howard C. Pyle, president of Monterey Oil Co. since November 1951, has been nominated as a Director of AIME. He graduated from the University of California in 1926 with a bachelor of science degree and subsequently received a master of science degree from the University of Southern California. During the first two years of development at Signal Hill, Mr. Pyle worked as a roustabout, pipe fitter, and roughneck. He was located in Venezuela as a geologist for the Union Oil Co. in 1927. In 1928 Mr. Pyle was transferred to California and in 1933 was promoted to petroleum engineer and chief production engineer. In January 1943 he entered the Army Corps of Engineers as a captain and was assigned to duty in Washington, D. C. He was later transferred to England to the general staff of General Eisenhower. During the Normandy invasion he served on Field Marshal Montgomery's staff. In October 1944 Mr. Pyle was promoted to lieutenant colonel and served as deputy chief of the G-4 petroleum branch, communications zone. He was discharged in 1945. At this time he was named vice president, Bank of America, a position he held until November 1947. For three years, Mr. Pyle was president of Continental Consolidated Corp. and Continental Corp. Prior to joining Monterey he was a consulting petroleum engineer in Los Angeles.

E. H. Rose, who has been nominated a Director of AIME for a three-year term, is a Member of the Southeast Local Section, AIME. Born at Kinsley, Kan., Mr. Rose is a graduate of the University of Kansas. He began his career as a mill superintendent with the Patino Mines, in Bolivia. From 1928 to 1930 he held the same position with the Moctezuma Copper Co. in Mexico. For six years Mr. Rose was assistant mill superintendent for the International Nickel Co. of Canada. In 1936 he was promoted to mill superintendent, a position he held until 1945. He was named consulting metallurgist for the Copper Range Co. on the White Pine project in Michigan during 1946. He joined the U. S. Steel Corp., Tennessee Coal & Iron Div. in 1947 and until recently was research engineer. He has been a member of the raw materials advisory committee, U. S. Atomic Energy Commission since 1949.


E. H. ROSE


J. W. VANDERWILT

John W. Vanderwilt, president of the Colorado School of Mines, Golden, has been nominated as a Director of AIME. Dr. Vanderwilt is a native of Oskaloosa, Iowa. He attended the University of Michigan and Harvard Graduate School. Following graduation from the University of Michigan, he was an instructor in geology at the University of Colorado, Boulder, Colo. For one year he was located in Washington, D. C., as a junior geologist with the U. S. Geological Survey. Dr. Vanderwilt returned to the University of Colorado as an assistant professor of mineralogy in 1928. From 1929 to 1934 he was an assistant geologist for the USGS. In 1934 Dr. Vanderwilt became a consulting mining geologist. In 1947 he returned to Colorado, as a member of the board of trustees, Colorado School of Mines and in 1950 was named president. In 1953 he became a member of the committee on mineral research, National Science Foundation.

Amend Nominating Method for Officers

Certain changes in the nominating procedure for AIME officers and directors were approved by the Board at its May 19 meeting. Briefly, the procedure in future will be as follows:

The Nominating Committee will consist of 18 members, none of whom shall be a director or director-elect. Eleven of these shall be named by the Council of Section Delegates, two by the Mining Branch Council, and one each by the Petroleum and Metals Branch Councils. The other three, including the chairman, shall be named by the president. The committee will meet during the week of the Annual Meeting, and will select a slate of nine names, one for President-elect, two for Vice Presidents, and six others for directors, all for three-year terms except the President-elect, who will successively become President and Past President. The committee will make its selections to the end that the directors come from different parts of the country and are representative of the various Divisions and Branches of the Institute. Twelve votes out of the 18 are required to name a candidate for the slate, the chairman having a vote. If no candidate receives 12 or more votes for the respective nine offices at the meeting of the committee, a letter ballot or ballots shall be conducted among the members of the committee within a 60-day period. If the letter ballots fail to provide nine candidates each with 12 or more votes, then the two highest candidates shall be submitted to all members of the Institute for letter ballot. Selections thus made will be published in the July issues of the AIME journals, with biographical sketches. Any 25 Members or Associate Members can then petition to have one or more additional names put on the ballot. If no such petitions are received by September 1, the nominations of the committee are accepted by the Board without a letter ballot.

The principal change just made by the Board is that a two thirds majority instead of a simple majority is necessary for selection of the candidates by the Nominating Committee.

Site Selected For 1957 Annual Meeting

Ample hotel space now being promised, the AIME Board has agreed to make New Orleans the scene of the 1957 Annual Meeting. The date will, however, be a week later than usual: February 25 to 28. The Mardi Gras celebration will occur the following week. The headquarters hotel has not yet been selected.

Professional Society Membership vs. Income

Engineers Joint Council has recently published a bulletin on the "Professional Income of Engineers." (Engineers Joint Council, 29 W. 39th St., N. Y.; price $1.) The information was gathered from questionnaires returned by 295 companies employing 65,169 engineers, supplemented by 12 Government agencies employing 3892 engineers, and by returns from 2977 individuals engaged in engineering education. The resultant graphs and data show the upper quartile, median, and lower quartile incomes according to the year of baccalaureate degree.

For all types of engineers, the starting salary paid last year averaged $340 per month; for those working in the field of the AIME, the average was up to $10 more than that figure. Data are consolidated in but two groupings in the mineral industries: (1) "Metal Mining and Primary Fabricated Metal Products Industries," and (2) "Extraction of Crude Petroleum and Natural Gas, and the Manufacture of the Products of Petroleum and Coal." No great difference is evident between these two. The median salary for the first year out of college starts at $4330 for (1) and $4572 for (2); rises to $6423 and $6557 respectively for ten years out of college; and reaches a peak of slightly over $11,000 for the two groups when about 35 years out of college.

The AIME itself has not compiled similar data about its members, but the AIChE last year published results of a questionnaire addressed to its own group, largely chemical engineers, of course. For the first ten years out of college the EJC and AIChE data were similar, but after that, the EJC survey showed that salaries began to level off, whereas the chemical engineers' salaries continued to rise. The median salary for engineers that graduated in 1930 was $8780 in the EJC survey, and close to $14,000 in the AIChE survey.

F. J. Van Antwerpen, editor of *Chemical Engineering Progress*, offers some interesting comment on this discrepancy, which applies also to AIME:

"Those who made the study for EJC . . . claim only that this survey is valuable in that it reports salaries of *all* engineers and is not 'limited by being restricted, for the most part, to members of professional societies.' Therein is probably the answer for the vast difference in salary experience after the 10-year level.

"Other surveys have revealed this same fact—members of a professional society command higher salaries. Many assumptions can be made as to why, but perhaps it is all summed up by saying that the man who joins a professional society is the man who looks upon engineering as a profession. The man who does not join his professional society looks upon engineering as a job, as a way of earning a living. As so often in life, devotion to a principle brings added things.

"Professional membership must have its influence on the work, the mental attitude, the information quotient, the conversational interests, and the pride of everyone who joins. And over the years, this might just make the difference."—E. H. Robie

Establish Principal Of Richards Award

The principal of the Robert H. Richards Award Fund has been definitely established as $7500. From the income in this Fund, a silver vanning plaque is periodically awarded for "achievement in any form which unmistakably furthers the art of minerals beneficiation in any of its branches," with men younger than 45 being favored. It is believed that the award can now be made annually and the Executive Committee has authorized the Award Committee to proceed with the selection of a candidate for 1955. S. J. Swainson is Chairman of the Committee and will welcome suggestions of men that should be considered for the Award.

International Meeting Plan Schedule Final

Plans have been completed for three international engineering meetings to be held in Rio de Janeiro and São Paulo, Brazil, between July 25 and Aug. 12, 1954.

The Sectional Meeting of the World Power Conference is scheduled for Rio de Janeiro, July 25 to August 10. The Fourth Convention of Inter-American Assn. of Sanitary Engineering is slated for São Paulo, July 25 to 31. The Third Convention of Pan American Federation of Engineering Societies (UPADI) is planned for São Paulo, August 2 to 12.

ASARCO Scholarships

The president of Montana School of Mines, J. R. Van Pelt, has announced that the American Smelting & Refining Co. has awarded two scholarships to Montana School of Mines for the year 1954-55, one to a student in mining and the other to a student in metallurgy. As in the past, the stipends will amount to $500 for each recipient who will be selected between now and the close of the present school year. These awards have been announced each year at commencement time and are recognized as among the most significant honors open to students at the School of Mines.

Around the Sections

• J. R. Macdonald, Dept. of Paleontology, South Dakota School of Mines and Technology, spoke to members of the **Black Hills Section** on *Fossil Mammals of South Dakota*. His lecture was accompanied by slides. Membership in the section has increased since the first of the year, it is reported.

• The **Washington, D. C., Section** heard Max W. Ball, oil and gas consultant and fellow member, discuss the Turkish oil situation at a recent meeting. The meeting, held at the National Press Club, was preceded by cocktails and dinner.

• Neil Plummer and Bill Rappold have been named to the Executive Committee of the **Utah Section.** Mr. Rappold is extremely active in the Industrial Minerals Div. Mr. Plummer, of Kennecott's Magna mills, has also been very active in AIME affairs.

• Next session of the **Tri-State Section** will be Sept. 11, 1954, coinciding with a visit from T. B. Counselman, AIME Vice President. The meeting will probably follow a reception for Mr. Counselman at the Conner Hotel, Joplin, Mo., and be followed by an informal dinner-dance.

• Kenneth B. Powell, superintendent of raw materials, Kaiser Steel Corp., Fontana, Calif, answered a special request by the **San Francisco Section** that he present his well-known paper, *Eagle Mountain Iron Ore Mine Operation*.

• Responsibility and liability connected with service contracts were elaborated upon before the **Southwest Texas Section,** Corpus Christi, by J. R. Sorrell. Mr. Sorrell is an attorney with Lewright, Dyer, Sorrell, & Redford, Corpus Christi.

• The **Adirondack Section** held its first meeting of the 1954 season at the Hotel Saranac, Saranac Lake, N. Y., with 49 members and guests present. Mr. and Mrs. C. M. Cooley, John Broughton, and Keith Block were special guests of the section. Adirondack Section boundaries were expanded and now include all of the southern counties of Oswego, Onondaga, Madison, Herkimer, Fulton, Saratoga, and Washington.

• Two divisions of the **Arizona Section,** AIME, held meetings during April. The Ore Dressing Div. met at the Hayden plant, Kennecott Copper Corp. at Hayden, Ariz., on Apr. 8, 1954. The technical session with G. P. Sewell, Chairman, included the following papers: *Hayden Concentrator Flow Sheet* by R. G. Woods, metallurgical chemist, and *Discussion of Concentrator Flow Sheet* by G. P. Sewell, assistant mill superintendent. Both authors are with the Hayden plant of Kennecott Copper Corp.

The meeting included an inspection tour of the Hayden concentrator. A total of 73 persons took part in the technical meeting and 96 attended the dinner.

• Members of the Smelting Div. of the **Arizona Section,** AIME, were guests of Phelps Dodge Corp., Morenci Branch, at Morenci, Ariz., on Apr. 16, 1954. In the morning 48 registrants were conducted through the Morenci smelter, and were served a lunch in the company dining hall.

In the afternoon technical session Harold Foard, International Smelting & Refining Co., presented a paper entitled *Experience with No. 4 Reverberatory Hearth Bottom*.

Cocktails and dinner were served to about 140 members, guests, and wives at the Morenci Club through the courtesy of the Phelps Dodge Corp. L. L. McDaniel, smelting superintendent of Phelps Dodge Corp., was Chairman of the meeting.

• Wing G. Agnew, Chief of District II of the Bureau of Mines, spoke to members of the **Spokane Subsection** on May 21 on the *Orientation of Diamond Bits*. This subject brought five members from British Columbia to the meeting.

Mr. Agnew reviewed briefly the types of shapes diamonds show—cubic, octahedral, and dodecahedral and their characteristics for wearability. Since 1949 diamonds have been oriented and cast in metals and considerable experience has been obtained both in the field and experimentally by the Bureau of Mines to obtain the best drilling characteristics. He pointed out that orientation of the crystals does not require much extra work but results in a great improvement in the life of the bits. Diamonds can be reused several times which further reduces costs. The ease of placing the diamonds with the proper orientation is strikingly described in U. S. Bureau of Mines' Reports of Investigations 4800, 4853, and 5015. A few concerns in the U. S. use the methods developed by the U. S. Bureau of Mines to orient the diamonds in the drill bits. Cast drill bits are cheaper than those made by powder metallurgy. Beryllium copper or beryllium nickel alloys are used.

• The final meeting of the season was held by the **Colorado Section** at the University Club, Denver, with John King, chief, Hot Springs, S. D., Office, Raw Materials Div., Atomic Energy Commission, as the main speaker. He lectured on *Exploration Phases of the Uranium Program in South Dakota*. Student Associate winner of the technical paper contest sponsored by the Colorado Section was Peter H. Cooper, Colorado School of Mines. He won a Brunton transit with leather carrying case.

• The University of Utah boasts one of the most active student chapters of the AIME. Among the many activities of the group was a recent meeting at which the group played host to the **Utah Section.** Chairman Marvin Barnes and his student affiliates presented a well-organized and entertaining program, in conjunction with the faculty of the School of Mineral Industries. The meeting was highlighted by Kenneth Cook, head of the Dept. of Geophysics, who spoke on geophysical methods of prospecting. Ninety students, members, and guests attended.

Three New Local Sections Approved

Three new Local Sections of the AIME have been approved:

Panhandle. This embraces the following counties in Texas: Hutchinson, Roberts, Hemphill, Oldham, Potter, Gray, Wheeler, Deaf Smith, Randall, Armstrong, Donley, Collingsworth, Parmer, Castro, Swisher, Hall, Briscoe, Childress, and possibly Hartley and Moore. Many of these counties had formerly been in the territory of the Oklahoma City Section. Officers are: 1st Vice Chairman, Joe M. Daniel, Jr.; 2d Vice Chairman, Jack C. Bendler; with T. S. Whitis, D. W. Jackson, and J. H. Ziser as directors.

Hugoton. This embraces the following counties in Texas: Hansford, Lipscomb, Dallam, Sherman, Ochiltree, and possibly Hartley and Moore. The following counties in Oklahoma: Cimarron, Texas, Beaver, Harper; in Colorado, Prowers and Baca; and in Kansas, Morton, Stevens, Seward, Meade, Clark, Ford, Gray, Haskell, Grant, Stanton, Hamilton, Kearny, Finney, Scott, Wichita, and Greeley.

Hobbs. This will be an "overlaying" Section embracing Petroleum Branch members in Lea, Eddy, Chaves, and Roosevelt Counties in New Mexico; and Gaines and Yoakum Counties in Texas. Some of these counties had previously been in the territory of other Local Sections.

Personals

Paul W. Chase has graduated from the University of Minnesota and is employed as a metallurgical technologist by the Quaker Oats Co., Akron, Ohio.

Dale C. Matthews is plant metallurgist, Anaconda Copper Mining Co., New Mexico operations, Grants, N. M.

Charles E. Tonry, formerly chief of the cost estimating unit and chief of the planning and evaluation section of the U. S. Bureau of Mine's oil shale demonstration plant, Rifle, Colo., has been named director of the Processing Div., Atomic Energy Commission, Grand Junction, Colo.

Wallace D. Barlow, formerly with the U. S Bureau of Mines, has been made head of the Resources Unit of the Office of Naval Material, Navy Dept. This office is concerned with the availability of the metals, minerals, and other basic materials required by the naval establishment.

J. M. Brashear, former open hearth furnace superintendent, Lone Star Steel Co., Lone Star, Texas, has been made general superintendent. **L. G. Graper,** vice president, research and development, has taken over the duties performed by **W. R. Bond,** vice president, operations. Mr. Bond recently resigned. **A. J. Malone,** who was superintendent of the production planning dept., is assistant general superintendent, steel div. **Glenn Anderson,** assistant superintendent of the blast furnace, is assistant general superintendent, coke-iron-ore div. **Stephen M. Purcell,** former assistant superintendent of the open hearth dept., is superintendent. **McCready Young,** who was construction auditor, is now superintendent, production planning dept.

Edward Steidle, dean emeritus of the College of Mineral Industries at Pennsylvania State University, and chairman of the Federal Coal Mine Safety Board of Review, is in Turkey on a 2-month special assignment. The Government of Turkey has requested Mr. Steidle to study its Mining Research & Exploration Institute, which corresponds to the U. S. Bureau of Mines plus the U. S. Geological Survey. Enroute to Turkey, Mr. Steidle stopped in Madrid to note progress of Spain's current mine modernization program.

Fred Elon Johnson, who was general manager Christmas mine, Riviera Mines Co., Ariz., is now with Banner Mining Co., Lordsburg, N. M.

Frank W. Millsaps, who was mill superintendent, Saudi Arabian Mining Syndicate Ltd., Jedda, Saudi Arabia, is with National Lead Co., Baxter Springs, Kans.

F. V. Hendershot, Orinoco Mining Co., has been transferred from New York to Cuidad Bolivar, Venezuela.

Giovanni Rossi has been appointed metallurgist at the flotation plant operated by the Montecatini Co. at Fenice Capanne, Italy. He received his M.S. in metallurgical engineering from Colorado School of Mines in January.

ROBERT HENDERSON

Robert Henderson, former general superintendent of the Climax Molybdenum Co. operation at Climax, Colo., has been appointed resident manager. He was employed by the International Nickel Co. in Canada before coming to Climax in 1936. Mr. Henderson worked first as an underground helper. He advanced through most of the jobs in the mine dept. and worked for a time in the engineering dept. Other recent appointments in the Climax operation include **Edwin Eisenach** to the post of assistant general superintendent and **William Wilson** to the position of company controller.

D. McKinley is mill metallurgist in the copper concentrator, East Sullivan mine, Val d'Or, P.Q. He was with the Opemiska copper mine, P.Q.

Ernest J. Maust, sales engineer with Western-Knapp Engineering Co., New York, is now with Western Machinery Co., New York.

W. L. Zeigler, general manager, Pend Oreille Mines & Metals Co., Metaine Falls, Wash., was honored June 6 by his alma mater, the University of Idaho. Mr. Zeigler, a widely recognized authority on mill design and milling technology, was awarded an honorary doctorate in science.

Lawrence Gussman, president of Stein, Hall & Co. Inc., New York, has announced the appointment of **S. Crawford Bonow** as manager, mfg. div., **Paul Kaplan** as manager, technical div., and **Albert R. Robbins** as manager of the New York laboratories. Mr. Bonow, formerly manager of the Long Island City plant, joined the firm in 1946.

Thomas H. Lentz, chemical engineer, General Mills Research Laboratories, Minneapolis, was the subject of a biographical sketch, "First Job," in *Progress Through Research*, published by General Mills. Mr. Lentz's chief advisor in flotation work is consultant **Donald W. Scott,** general manager, Continental Sales & Equipment Co., Hibbing, Minn.

Virgil Lessels is concentrator metallurgist, White Pine Mining Co., White Pine, Mich.

Paul T. Benson has retired as general superintendent, Tacoma Smelter, American Smelting & Refining Co., Tacoma, Wash. Mr. Benson first joined Asarco in 1925 as assistant refining superintendent of the Tacoma Smelter.

L. M. Coffey has returned to Bangkok, Thailand, after an extensive tour of Europe. He is now manager, engineering dept., Henry Waugh & Co. Ltd., Bangkok.

Armand J. Eardley, professor of geology and chairman of the Div. of Earth Sciences, has been appointed dean of the College of Mines and Mineral Industries, University of Utah, Salt Lake City. He succeeds **Carl J. Christensen,** who has been named coordinator of cooperative research. Mr. Eardley came to the University of Utah in 1949.

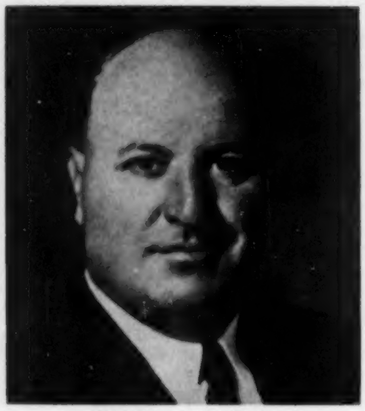
A. F. Banfield of Behre Dolbear & Co., New York, has been examining glass sand deposits in Alberta. **Parke A. Hodges** of the same company is in Colorado. He was recently in Cuba.

John W. Newett, formerly chief engineer, New Cornelia Branch, Phelps Dodge Corp., Ajo, Ariz., is now general manager, Cochise Publishing Co., Bisbee, Ariz.

Evan Just, since 1952 vice president Cyprus Mines Corp., New York, was a speaker at the 54th annual commencement of Montana School of Mines, Butte.

Edgar C. Bain (Robert W. Hunt Medalist, AIME 1929, Howe Memorial Lecturer, AIME 1932) has been elected a member of the National Academy of Sciences. Mr. Bain is vice president in charge of research and technology, U. S. Steel Corp., Pittsburgh.

Edgar W. Engle, manager of product and process development engineering, Carboloy Dept. of General Electric Co., Detroit, has been named manager of cemented carbide products engineering. Mr. Engle has been active in manufacturing and developing cemented carbides since he came to Carboloy in June 1941 as a foreman. He became metal dept. foreman in 1945; manager of process engineering in 1950, and manager of product and process development engineering in 1952.



JOSEPH A. MARTINO

Joseph A. Martino, president of National Lead Co., New York, has accepted the chairmanship of the metals div. of the Committee of American Industry. Mr. Martino and his committee will canvass the nonferrous segment of the metals field in behalf of the National Fund for Medical Education.

John F. Haynes, who was with U.S. Bureau of Mines in Tucson, Ariz., is now in Waco, Texas. He is project engineer for the spot drilling program of Region IV, USBM.

William S. Adams is assistant mill superintendent, Opemiska Copper Mines, Ltd., Opemisca via St. Felicien, P. Q.

G. Dessau, formerly of the Italian Colonial Mining Service, and after World War II attached to the Italian Geological Survey, is now associate professor of mineral deposits at the University of Naples, besides being engaged in consulting work.

Roy B. Earling has been appointed to direct a study of operations of the U. S. Dept. of the Interior in Alaska. Mr. Earling was for many years vice president and general manager, Alaskan Operations, U. S. Smelting Refining & Mining Co., Fairbanks.

Richard A. Cabell, assistant secretary, and **Paul Queneau,** metallurgical engineer, have been elected to the additional positions of assistant to the vice president of International Nickel Co. of Canada Ltd. Their headquarters will be in New York.

Carroll L. Wilson, director of Industrial Development of the Climax Molybdenum Co. and former manager of the AEC, has been elected vice president and general manager of Metals & Controls Corp., Attleboro, Mass.

JAMES P. POLLOCK

James P. Pollock has been appointed chief geologist, Calumet & Hecla, Calumet, Mich. He succeeds **Thomas M. Broderick** who has retired after 34 years with the metal producing and fabricating company. Before joining Calumet & Hecla last year, Mr. Pollock served with the U. S. Geological Survey in 1940 and as an exploration geologist in the Southwest and in Peru with American Smelting & Refining Co. from 1941 to 1953.

Donald H. McLaughlin, president, Homestake Mining Co., San Francisco, delivered the commencement address at the 57th annual graduating exercises of the New Mexico Institute of Mining and Technology, Socorro.

Clifford F. Hood, president, U. S. Steel Corp., was one of the ten U. S. business and civic leaders who recently received Horatio Alger awards in New York. These plaques are conferred annually in recognition of public accomplishments and civic achievement that serve as an example to American youth. When Mr. Hood was 10 years old he was making 50¢ a day as a water boy for a threshing crew. He joined U. S. Steel in 1917 as a clerk.

Morris M. Leighton, chief, Illinois State Geological Survey, Urbana, has retired after 31 years of service as chief and 35 years as geologist. His successor is **John C. Frye,** professor of geology, University of Kansas.

John O. Nigra, associate professor of geology, Tulane University, has been awarded a post-doctoral fellowship for the 1954 to 1955 academic year by the State Dept. under the Fulbright Act. Mr. Nigra leaves New Orleans in August for the Middle East to lecture at the College of Engineering at Baghdad. His address will be c/o U.S. Embassy, U.S. Educational Foundation, Baghdad, Iraq. On completion of his commitments there, Mr. Nigra will attend the World Petroleum Congress in Rome in 1955 before returning to the U.S.

JOHN R. BOGERT

John R. Bogert is now employed as a mining geologist with Cerro de Pasco Corp., New York. He was with Kennecott Copper Corp., Lima, Peru.

Stanley McDougall, mine superintendent, Bunker Hill & Sullivan Co., Kellogg, Idaho, has been promoted to a newly created position of manager of mines.

George D. Creelman, who was with M. A. Hanna Co., Cleveland, is now president, Creelman Associates, 2245 Harcourt Drive, Cleveland.

Christian F. Beukema has been appointed vice president Michigan Limestone Div., U. S. Steel Corp., Detroit.

M. D. Cooper has been elected chairman of the Mining Standards Board of the American Standards Assn. Mr. Cooper, National Coal Assn., will represent the Coal Mining Institute of America. Serving as vice chairmen are **Otto Herres** and **M. H. Forester.** Mr. Herres, Combined Metals Reduction Co., will represent the AIME, and Mr. Forester, Pittsburgh Consolidation Coal Co., will represent the National Coal Assn. Members of the Executive Committee are **S. H. Ash,** representing the U. S. Bureau of Mines, and **D. Stoetzel,** General Electric Co., representing National Electrical Manufacturers Assn.

H. Dodge Freeman, Lake Forest, Ill., has been elected a vice president of White Pine Copper Co., subsidiary of Copper Range Co. **Donald E. Moulds,** at present general manager of the Mining Div., Copper Range Co., was also elected vice president. Mr. Freeman will be located in Michigan, where construction of the White Pine mine project is nearing completion. He joins White Pine Copper Co. following 12 years in executive and management capacities with Peabody Coal Co.

Allyn E. Harper, formerly chief engineer, Oliver Iron & Steel Corp., Pittsburgh, has been appointed chief, mechanical engineering div., E. J. Longyear Co., Minneapolis.

George R. Schaefer has resigned his position as manager of Minas de Matahambre, Province de Pinar del Rio, Cuba, and is temporarily residing at 2512 Mt. Brook Circle, Birmingham.

Thomas H. Wickenden has retired as vice president and manager of the development & research div., International Nickel Co. Inc., New York. He will continue with the company as a consultant. His successor is **Frank L. LaQue,** who has been head of the corrosion engineering section of the division in New York since 1945. Serving as assistant managers of the division are **O. B. J. Fraser** and **Donald J. Reese.** Mr. Fraser, vice president, AIME, has had wide experience in the company's research facilities and plants in Canada and the U.S., including 8 years as head of Inco's largest U.S. research laboratory. Mr. Reese has been in charge of the technical field sections of the company throughout the U.S. and Canada and has had close association with the division's development work.

Douglas H. Pack, metallurgical and chemical engineer, Kennecott Copper Corp., Salt Lake City, is now assistant research professor, Dept. of Fuel Technology, University of Utah.

J. D. McAULIFFE

R. C. Mahon, superintendent of the Homer and Wauseca iron mines, M. A. Hanna Co., Iron River, Mich., has retired but will be retained in a consulting capacity in connection with Hanna's operations in the Iron River district, Menominee iron range. Mr. Mahon has been a mining engineer and mine superintendent in this district for the past 42 years. **James Ivers, Jr.,** has been appointed superintendent of the Homer mine and **J. D. McAuliffe** has been appointed superintendent of the Wauseca mine.

ALVIN KAUFMAN

Alvin Kaufman, who was administrative assistant, Hudson Coal Co., Scranton, Pa., is now commodity industry analyst, U. S. Bureau of Mines, Pittsburgh.

G. R. Harris of Denver has announced formation of a new firm to distribute heavy construction equipment for Joy Mfg. Co. The firm also will sell cable, tractors, and other industrial supplies. Executive offices will be in the First National Bank Bldg. and sales office will be located at 1340 South Lipan St., Denver. Mr. Harris is a director of Potash Co. of America.

Morris F. La Croix, a senior partner of Paine, Webber, Jackson & Curtis and president of Copper Range Co., was awarded an honorary degree of Doctor of Engineering from Michigan College of Mining & Technology at the recent commencement. The citation outlined Mr. La Croix's career as engineer, geologist, and mining executive in the State of Michigan and noted that as president of Copper Range he was responsible for the development of copper-bearing orebodies that have opened new areas of prosperity for Michigan's Upper Peninsula.

George L. Ratcliffe, general manager Baroid Sales Div., National Lead Co., has been succeeded by **George B. Coale,** chief engineer, National Lead Co. Mr. Ratcliffe will remain active with the Baroid Sales Div. in his capacity of vice president of National Lead Co.

Roy K. Alexander, Gardner-Denver Co., has been transferred from San Francisco to Minneapolis as resident engineer.

Chester D. Vaughan is research metallurgist, Howe Sound Co., Holden, Wash.

Zana Earl Arlin is with Anaconda Copper Mining Co., Grants, N. M. He was geological engineer, Darwin Mines, Darwin, Calif.

WALTER P. GILLINGHAM

James E. Edmunds, chief mining engineer, Potash Co. of America, has been transferred from Carlsbad, N. M., to Saskatoon, Saskatchewan. **Walter P. Gillingham,** who was an engineer in the mining dept. at Carlsbad, has also joined the Canadian subsidiary in Saskatoon.

De Witt C. Peck, Jr., mining engineer, is with Cia. Minera de Peñoles, Avalos, Zacatecas, Mexico.

Raymond E. Zimmerman, vice president, Paul Weir Co., Chicago, is doing field work in Zonguldak, Turkey.

Obituaries

An Appreciation of
George O. Deshler
by T. R. Herndon

George O. Deshler (Member 1913) was born in Eaton, Pa., on May 10, 1884 and died in El Paso, Texas, on May 13, 1954.

He was graduated from Lafayette College with an E.M. degree in 1908. He is survived by his wife, Maxine, a daughter, Mrs. Frank Anderson, of Phoenix, Ariz., two sons, George A. of Mullen, Idaho, and William of Boise, and seven grandchildren.

After 1908 he was employed by the USGC, and at various mines both in the eastern and western parts of the U. S. In 1914 at the Timber Butte mill in Butte, Mont., he became deeply interested in the treatment of the complex lead-zinc ores. It was during his 7 years at Timber Butte in mill and laboratory work that these ore dressing problems were finally solved with the result that both a lead flotation concentrate and a zinc flotation concentrate were produced.

The San Francisco Mines of Mexico Ltd., faced with a similar problem, employed George for a short period of time as a consultant with the title of assistant mill superintendent and metallurgist. His metallurgical knowledge proved to be invaluable to the San Francisco Mines, and this short period stretched out to 30 years and became his life work. In 1929 he was made mill superintendent. He was promoted to assistant general superintendent in 1940 and later to general superintendent. In 1952 he retired from active service with the San Francisco Mines but was retained as a consulting metallurgist. George was on one of his periodic trips from his home in Tucson, Ariz., to the mine when he was taken ill.

It was my privilege to be associated with George from 1934 to 1954. George had many close friends, and we all admired his extensive knowledge of science, his integrity and fine sense of justice.

An Appreciation of
William Orange Vanderburg
by Elmer W. Pehrson,
Regional Director, Foreign Minerals Region, U. S. Bureau of Mines

William O. Vanderburg, State Dept. mining engineer and internationally recognized expert on mineral production and supply, died on Apr. 16, 1954, at the Bethesda Naval Hospital after a long illness. He was buried at Arlington National Cemetery, Fort Myer, Va., on April 21.

Mr. Vanderburg was born on Jan. 18, 1896 at Muskegon, Mich. His education was interrupted during World War I by a 2-year tour of duty with the U. S. Army which included overseas assignment to France. He returned to the Michigan College of Mines where he obtained his B. Sc. in 1920 and an Engineer of Mines in 1923. After several years spent in the practice of his profession in industry he joined the staff of the U. S. Bureau of Mines in 1929, where he was engaged chiefly in strategic mineral investigations in Nevada and other Western States. In 1941 the Bureau sent him to Lima, Peru, to assist in expanding strategic mineral production in that country for the U. S. defense program.

In June 1942 Mr. Vanderburg transferred to the Foreign Service of the Dept. of State and was assigned to the Embassy in Lima as Minerals Attaché. He served in a similar capacity at Johannesburg and Pretoria in the Union of South Africa from May 1945 to March 1951. Following a year's service as examining engineer for the Economic Cooperation Administration in Paris, he moved to London in May 1952 where he served as an Embassy Attaché with the European headquarters of the Defense Materials Procurement Agency, later the Emergency Procurement Service. At the time of his return to the U. S. for hospitalization in October 1953, he was chief mining engineer of that organization.

In his numerous foreign assignments Mr. Vanderburg played an important role in the procurement of strategic minerals under the various defense, war, and stockpiling programs of the U. S. Government. Because of his expert knowledge and judgment his advice was sought frequently by Ambassadors and other Government officials and private business executives. His wise counsel and warm friendship will be sorely missed by his many friends and associates in and out of Government.

Mr. Vanderburg leaves to mourn his passing, his wife, the former Miss Frances McClary of Ironwood, Mich., whom he married in September 1925; a son, William O., Jr., and a grandson of Portland, Ore.; a daughter, Miss Gretchen Vanderburg; four brothers, Isaac, Louis, Vincent, and Corniel; and two sisters, Miss Josephine Vanderburg and Mrs. Ernest Olander.

He was a member of the Masonic Order and the Veterans of Foreign Wars. He was also an active member of the AIME (1929) and the Mining & Metallurgical Society of America.

A Memorial
Charles T. Van Winkle
From the Utah Section, AIME

The death of Charles T. Van Winkle (Member 1912) on Mar. 29, 1954 brought to his fellow-members of the Utah Section of the AIME memories of personal friendship, of help always extended when needed, and increased realization of the influence that he had wielded during his 9 years as Secretary and one year each as Vice Chairman and Chairman from June 1923 to June 1934.

He worked tirelessly, quietly, and cooperatively during a trying economic period to shape and to advance the ideals that characterize the Institute: that discoveries in science and their technical applications are the essentials making possible advances in the Nation and in civilization; that in this field all members can work concentratedly with best results for the common good, with the least dilution of effort through conflicts of interests, and with the best cooperation of all groups in the mining industry needed to obtain, to interpret, and to disseminate technical knowledge.

The Utah Section of the AIME, through its Executive Committee wishes to acknowledge the debt they owe to Chas. T. Van Winkle. They wish to express their admiration for the unselfish traits of his character that make it possible for many diverse groups to work in confidence with him toward chosen goals, and their sympathy to his bereaved family for their loss.

This memorial has been passed as a resolution by the Utah Section, to be spread upon the minutes of the Section and in the National publications of the Institute, and copies are to be sent by the Executive Committee to Richard A. Van Winkle and to other members of the family.

The Executive Committee,
Utah Section
Roger V. Pierce, J. M. Ehrhorn,
C. R. Fish

Necrology

Date Elected	Name	Date of Death
1928	Colvin B. Brown	Unknown
1913	George O. Deshler	May 13, 1954
1894	Donald G. Forbes	Unknown
1933	Donald C. Gregg	Unknown
1917	A. A. Hoffman	May 4, 1954
1909	Irving S. Josephs	Unknown
1941	Richard Maize	Unknown
1942	Frank E. Mueller	May 21, 1954
1954	Walter Van Rawson	Unknown
1926	Paul T. Seashore	Apr. 11, 1954
1916	Charles B. Strachan	Sept. 17, 1953
1929	William O. Vanderburg	Apr. 16, 1954
1912	C. T. Van Winkle	Mar. 29, 1954

Proposed for Membership
MINING BRANCH, AIME

Total AIME membership on May 31, 1954 was 20,762; in addition 1661 Student Associates were enrolled.

ADMISSIONS COMMITTEE

O. B. J. Fraser, Chairman; P. B. Caples, Vice-Chairman; F. A. Ayer, A. C. Brinker, R. H. Dickson, Max Gensamer, Ivan A. Given, Fred W. Hanson, T. D. Jones, Sidney Rolle, J. H. Scaff, John T. Sherman, F. T. Sisco, Frank T. Weems, R. L. Ziegfeld.

The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

In the following list C/S means change of status; R, reinstatement; M, Member; J, Junior Member; A, Associate Member; S, Student Associate.

Alaska
Anchorage—Kirkpatrick, M. B. (A)
Suntrana—Swalling, Albert C. (A)

Arizona
Jerome—Hargraves, Robert B. (J)
Morenci—Davis, Hale O. (A)
Ray—Dickerson, Arthur L. (A)
Ray—Miller, Leonard J. (A)
San Manuel—Patrick, Roger B. (M)

Arkansas
Benton—Buchan, Michael A. (M)
Little Rock—Hardy, William McC. (M)

California
Berkeley—Rathjens, George W. (R. M)
Fresno—Morrison, Carl H. B. (A)
San Francisco—Jenkinson, Donald W. (M)
San Leandro—Turney, Paul M. (R. C/S—S-M)
San Mateo—Vieira, Joseph L. (A)

Colorado
Denver—Matthews, Christian W. (M)
Denver—Payne, William L., Jr. (M)
Grand Junction—Congdon, Thomas E. (A)
Grand Junction—Toerper, Ralph C. (M)
Leadville—Navias, Robert A. (J)

Florida
Lakeland—Mills, Clyatt E. (A)

Illinois
Chicago—McClelland, Benjamin E. (R. C/S—J-M)

Massachusetts
Cochituate—Gibson, Kenneth H. (J)

Michigan
Birmingham—Suliot, Jack N. (M)

Minnesota
Hibbing—Chisholm, Robert H. (M)

Nevada
Reno—Roy, Robert F. (J)

New Jersey
Verona—Ravnsborg, Norman T. (C/S—A-M)

New Mexico
Santa Fe—Murphey, Clarence H. (A)

New York
Chappaqua—Fenwick, Paul (M)
Levittown—Reynolds, Leander G. (A)

Ohio
Athens—Stevens, Paul M. (R. C/S—S-J)

Oregon
Corvallis—Wilkinson, William D. (M)

Pennsylvania
Bridgeville—Tilton, James G. (R. C/S—S-M)
Chester Springs—Franklin, James W. (A)
Conyngham—Butler, William C. M., Jr. (M)
Hazelton—Hildebrand, John F. (A)
Ithan—Geer, Irving S. (M)
Pottsville—Jones, William L. (J)
Shavertown—Otto, Henry H., Jr. (A)
State College—Jones, Robert L. (J)

South Dakota
Lead—Rizzi, Theophilus M. (R. C/S—S-A)
Rapid City—Drevdahl, Elmer R. (C/S—J-M)

Texas
El Paso—Brown, John P. (C/S—J-M)
Houston—Fogarty, Charles F. (M)

Utah
Midvale—Hartvigsen, Lionel M. (A)
Murray—Gardner, John R. (M)
Salt Lake City—Allen, Earl W. (M)
Salt Lake City—Kuhn, William C. (A)
Salt Lake City—Tainter, Stanton L. (M)
Salt Lake City—Wright, Earl L. (A)

Virginia
Richmond—Roberts, John W. (M)

Washington
Seattle—Stolwyk, David J. (J)
Spokane—Reno, Horace T. (R. C/S—S-M)

West Virginia
Bluefield—Gerdetz, Robley E. (M)
Martinsburg—Mueller, Louis J. (M)

Wisconsin
Milwaukee—Schindler, Frederick C. (A)

Australia, West
Mt. Magnet—Boundy, Clive A. Paul (M)

Burma
Rangoon—Svanholm, John W. (M)

Canada
Alberta, Edmonton—Newman, William R. (M)
Ontario, Lively—Craven, Wilford C. (C/S—A-M)
Ontario, Sudbury—Van Raadshooven, Willem H. (M)

Germany
Clausthal-Zellerfeld—Schranz, Hubert W. (R. M)

India
Calcutta—Ghose, Hiran K. (M)

Malaya
Selangor—Hickson, William S. (A)

Peru
Cerro de Pasco—Toelle, Harry A. (C/S—J-M)
Lima—Parfet, Stanley W. (M)

— Coming Events —

July 25-Aug. 10, World Power Conference, sectional meeting, Rio de Janeiro, Brazil.

Aug. 8-13, Pan American Federation of Engineering Societies (UPADI), 3rd convention, São Paulo, Brazil.

Sept. 8-10, American Society of Mech. Engrs., fall meeting, Schroeder Hotel, Milwaukee.

Sept. 9, AIME, San Francisco Section, Engineers' Club, San Francisco. AIME President Leo F. Reinartz, speaker.

Sept. 10, AIME Lehigh Valley, annual inspection trip, Ingersoll-Rand Co., Phillipsburg, N. J.

Sept. 12-16, American Institute of Chemical Engineers, national meeting, Hotel Colorado, Glenwood Springs, Colo.

Sept. 13-14, American Coke & Coal Chemicals, annual meeting, The Homestead, Hot Springs, Va.

Sept. 15-29, International Union of Geodesy & Geophysics, 10th general assembly, Rome, Italy.

Sept. 20-24, American Mining Congress, Civic Auditorium, San Francisco.

Sept. 23-24, Central Pennsylvania Coal Producers Assn., annual meeting, Bedford Springs Hotel, Bedford, Pa.

Sept. 24, AIME, Minerals Beneficiation Div., fall meeting, Fairmont Hotel, San Francisco.

Sept. 26-29, American Society of Mechanical Engineers, Petroleum Mechanical Engrg. Conference, Hotel Statler, Los Angeles.

Sept. 30, AIME Utah Section, stag; cocktails, dinner, smoker, 7:00 pm Newhouse Hotel.

Oct. 5-9, AIME Industrial Minerals Div., fall meeting, Whiteface Inn, Lake Placid, N. Y.

Oct. 17-20, AIME Petroleum Branch, Plaza Hotel, San Antonio.

Oct. 18-22, American Society of Civil Engineers, annual meeting, Hotel Statler, New York.

Oct. 18-22, National Safety Congress and Exposition, Chicago, Ill.

Oct. 26, Assn. of Consulting Chemists and Chemical Engineers Inc., annual symposium and banquet, Hotel Belmont Plaza, New York.

Oct. 27-29, Clay Mineral Technology, Third National Clay Minerals Conference, Rice Institute, Houston.

Oct. 28-29, Engineers' Council for Professional Development, Hotel Alms, Cincinnati.

Oct. 28-29, AIME, ASME Fuels Conference, William Penn Hotel, Pittsburgh.

Oct. 29, AIME, NOHC and Pittsburgh Local Section, off-the-record meeting, William Penn Hotel, Pittsburgh.

Oct. 29-30, AIME, Industrial Minerals Div., Rocky Mountain Region Industrial Minerals Conference, Salt Lake City. Registration Oct. 28.

Oct. 30, AIME, Utah Section, annual fall cocktail party, dinner dance, 7:00 pm, Newhouse Hotel, Salt Lake City.

Nov. 1-3, AIME, Institute of Metals Div., fall meeting, Hotel Morrison, Chicago.

Nov. 1-3, Geological Society of America and Associated Societies, Statler and Biltmore hotels, Los Angeles.

Nov. 8-11, American Petroleum Institute, 34th annual meeting, Conrad Hilton Hotel and Palmer House, Chicago.

Nov. 12, Illinois Mining Institute, Hotel Abraham Lincoln, Springfield, Ill.

Nov. 15, AIME, Utah Local Section, joint meeting with Intermountain Assn. of Petroleum Geologists, 8:00 pm, Newhouse Hotel, Salt Lake City.

Nov. 18, American Mining Congress, Coal Div., Wm. Penn Hotel, Pittsburgh.

Nov. 28-Dec. 3, American Society of Mechanical Engineers, annual meeting, Hotel Statler, New York.

Dec 1-4, AIME Electric Furnace Conference, William Penn Hotel, Pittsburgh.

Dec. 13-15, American Institute of Chemical Engineers, annual meeting, Statler Hotel, New York.

Dec. 26-31, American Assn. for the Advancement of Science, national meeting, University of California, Berkeley, Calif.

Feb. 14-17, 1955, AIME, Annual Meeting, Conrad Hilton Hotel, Chicago.

Advertisers' Index

* Previous Issues

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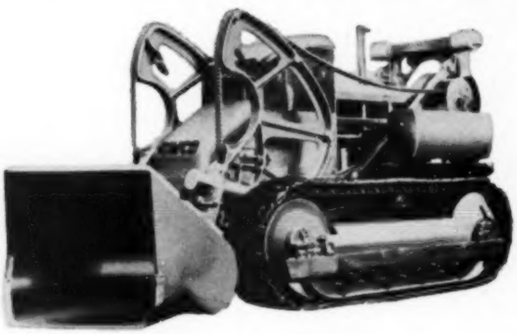

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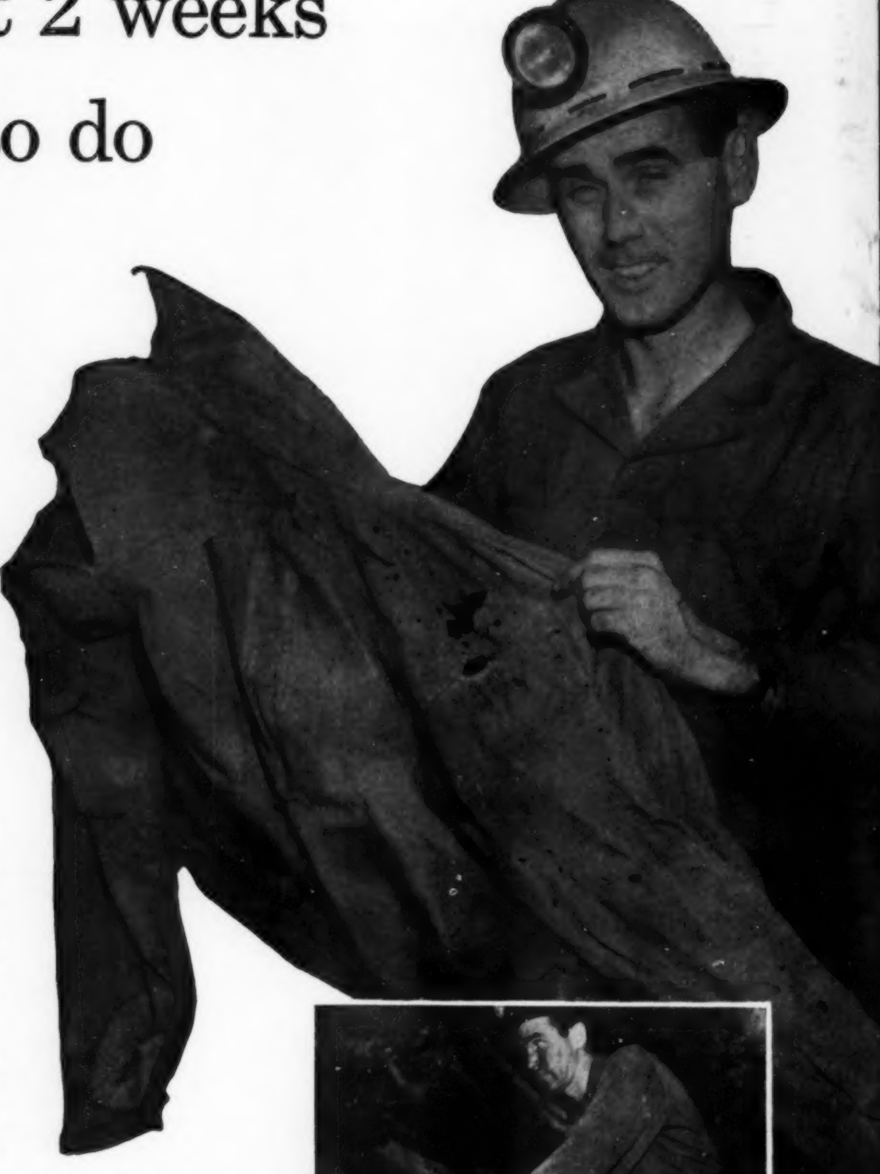

—says A. F. PARR
Engineer
Mountain Copper Company

Iron pyrite ore, through action of ground water, is partially reduced to sulphuric acid . . . diluted but still powerful-acting. This acid, although harmless to the body, caused ordinary work clothes worn by miners at Mountain Copper Company's Hornet Mine to fall into half-rotted shreds in two weeks' time, and often less.

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